

# SIMGEN SOFTWARE USER MANUAL

## SOFTWARE FOR THE SPIRENT RANGE OF SATELLITE NAVIGATION SIMULATOR PRODUCTS

DGP00686AAA Issue: 6-00 Date of Issue: 29 September 2016
Document status: OFFICIAL

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# 1 General

***Note**: The term "simulator" refers to a configured arrangement of signal generator(s), computer controller(s) and ancillary items.*

Spirent reserves the right to supply simulator elements that may be superficially and visually different to those shown in an interconnection drawing, but which provide equivalent or better performance.

From PosApp version 6.00 onwards for the GSS7000 signal generator, SimGEN runs on the GSS7000 Embedded Host.

From PosApp version 5.0 onwards for GSS9000-series signal generators, SimGEN runs on the C50r SimGEN Host running Windows 7 Professional for Embedded Systems ESD (Virtualisation Only).

From PosApp version 5.0 onwards for GSS8000-series (and earlier) signal generators, SimGEN runs on the SimGEN Controller running Windows 7.

## 1.1 This issue

***Note**: "SimGEN release" refers to the SimGEN release for which this user manual is valid.*
*Earlier releases of SimGEN may have reduced functionality compared with this release.*
*Spirent recommends you always use the latest SimGEN release.*

| Issue | Date | SimGEN release | Description |
|---|---|---|---|
| 6-00 | Sept. 2016 | 6-00 | Bugz:<br>14211: Update FPGA Image Loader<br>14199: 9000/7000 high rotation rate uses SimGEN processing<br>14192: Updated Host controller utility<br>14114: Support for GSS7000<br>13766: Colour scheme in Power Levels Graph<br>13744: Add Control options-channel centric view<br>13701: Add SimROUTE details<br>13608: 7000 channel usage<br>13572: Tools menu update |

New in this release:

→ Support for GSS7000

## 1.2 The GSS7000 signal generator

The GSS7000 incorporates an Embedded Host running Linux and Windows 7 Professional for Embedded Systems ESD (Virtualisation Only).

The GSS7000 Embedded Host operates in a similar way to the C50r SimGEN Host.

### 1.2.1 Licence management

Each GSS7000 signal generator uses up to four channel banks to provide up to 64 channels per bank of simulated GNSS signals. Your licence sets up the channel bank(s) to generate signals from any constellation operating within a single frequency band.

Upgrading your signal generator to generate signals in a new frequency band is as simple as purchasing the relevant licence from Spirent. You may need to install additional channel banks if you want to generate new signals in addition to the signal your current licence permits.

In addition, Spirent may be able to licence additional features to you, for example ULTS / PLTS, contact Spirent to discuss this.

### 1.2.2 Installing a licence file

Spirent ships your GSS7000 with its licence installed.

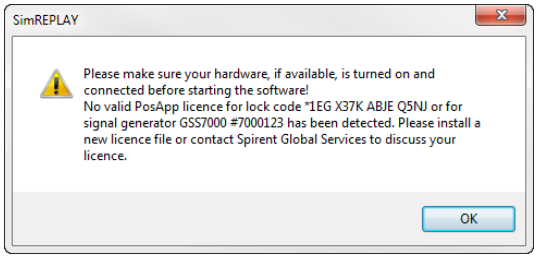
If you need to re-install your licence, or install a new licence, follow the procedure in this section.

Spirent uses a SimGEN specific licence file to enable the SimGEN software.

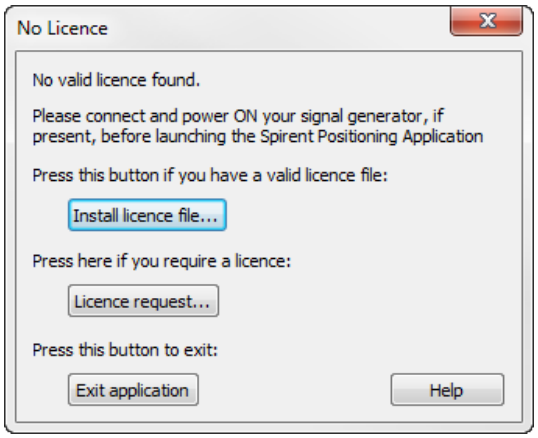

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Each signal generator uses a separate licence.

Spirent installs the licence file to the *SimGEN* folder using the name *lservrc.txt*; and also saves the licence file, using its original name, to the licence history folder…*SimGEN\licence history*.
If you delete *lservrc.txt* you will see this warning the next time you run SimGEN:




→ Click **OK** to display the **No Licence** dialog:




→ ***If you have a licence file from Spirent, c***lick **Install licence file…** and navigate to the licence file that Spirent supplies

→ After you select the licence file, a dialog requests you confirm installation of the licence file

→ After you confirm the installation, click **OK** to exit SimGEN

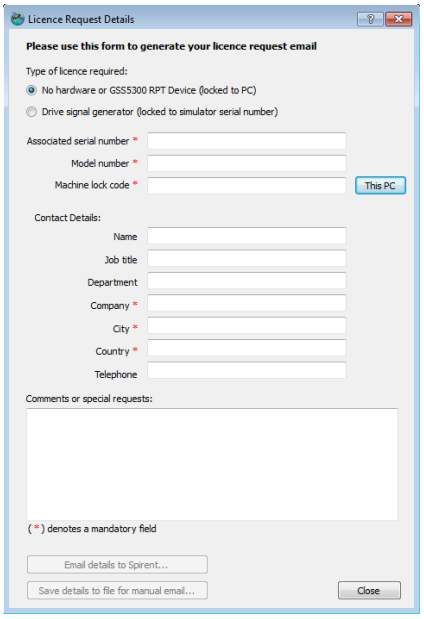
→ Restart SimGEN by double-clicking the desktop icon

If you do not have a Spirent licence file see ***Licence requests*** (page 1-2).

### 1.2.2.1 Licence requests

To obtain a licence, follow ***Installing a licence file*** and run SimGEN. When you get to the step “Click **OK** to display the **No Licence** dialog:” click **Licence Request** and complete the **Licence Request Details** dialog shown below.


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Fields highlighted with * denote mandatory fields. You must enter data in these fields to enable **Email details to Spirent…**:

**Type of licence required** depends on your signal generator:

→ In **Associated serial number,** enter the serial number of your GSS7000 signal generator. Click **This PC** to generate a lock code that Spirent uses to generate the licence file.

Click **Email details to Spirent…** to send a licence request e-mail to Spirent.

If your PC does not have an internet connection, click **Save details to file for manual email…**. You can then E-mail this file to Spirent Global Services at: licence_pt@spirent.com.

### 1.2.3 SimGEN running on the Embedded Host

PosApp separates the Graphical User Interface, the GUI, (*PosApp.exe*) from the engine, (*PosApp_engine.exe*) to optimise GSS7000 signal generator performance; the engine runs on a real-time operating system (Linux), while the GUI remains operating on Windows, which runs on a Virtual Machine.

Separate Embedded Host processors (one each for engine and GUI) provide adequate performance for calculation of parameters, such as vehicle trajectories for up to 256 simulated satellite channels. The engine calculates the new parameters and sends them to the signal generator in time for the next epoch. The Embedded Host uses an internal PCIexpress interface to the GSS7000 signal generator to transfer the large amount of data generated.

### 1.2.4 Using the GSS7000 on a corporate LAN

For optimum performance of your GSS7000 simulator, Spirent recommends:

→ You do not connect your GSS7000 to a corporate LAN if that LAN uses the subsets 192.168.25.x or 192.168.26.x

→ Before running any scenario, you disconnect your GSS7000 from a corporate LAN

### 1.2.5 File locations

The following tables detail the locations Spirent uses to install SimGEN and its components to the Embedded Host.

**Folders associated with the PosApp gui**

| Folder | Location on Embedded Host |
|---|---|
| PosApp gui | Folder: *D:\posapp\software\<version>\gui* |
| BeiDou data sets | Folder: *D:\posapp\software\<version>\gui \Beidou_data_sets* |


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| Folder | Location on Embedded Host |
|---|---|
| Datum files | Folder:<br>*D:\posapp\software\<version>\gui \Datum Files* |
| Documents | Folder:<br>*D:\posapp\software\<version>\gui\Docs* |
| Firmware upgrade utility | Folder:<br>*D:\posapp\software\<version>\gui \Firmware Upgrade Utility* |
| Galileo data sets | Folder:<br>*D:\posapp\software\<version>\gui \Galileo_data_sets* |
| Interface files | Folder:<br>*D:\posapp\software\<version>\gui \interface files* |
| Log files | Folder:<br>*D:\posapp\logs* |
| QZ files | Folder:<br>*D:\posapp\software\<version>\gui*<br>*\QZ files* |
| SimAUTO | Executable:<br>*D:\posapp\software\<version>\gui* |
| System data | Folder:<br>*D:\posapp\conf* |
| Tools | Folder:<br>*D:\posapp\software\<version>\gui*<br>*\tools* |
| Utilities | Folder:<br>*D:\posapp\software\<version>\gui* |
| SBAS datasets | Folder<br>*D:\posapp\software\<version>\gui\SBAS_data_sets\<constellation>* |

**Folders associated with the PosApp engine**

| Folder | Location on Embedded Host |
|---|---|
| PosApp engine | Folder:<br>*D:\posapp\software\<version>\engine* |
| Firmware | Folder:<br>*D:\posapp\software\<version>\firmware* |
| Scenarios | Folder:<br>*D:\posapp\scenarios* |
| Scripts | Folder:<br>*D:\posapp\software\<version>\scripts* |

**Folders associated with Scenarios**

| Folder | Location on Embedded Host |
|---|---|
| Scenarios | Folder:<br>*D:\posapp\scenarios* |
| Shared folder | Folder:<br>*D:\posapp\scenarios\shared* |



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**Files associated with PosApp**

| Files | Location on Embedded Host |
|---|---|
| *lservrc.txt* | Folder:<br>*D:\posapp\conf* |
| *sig_gen.txt* | Folder:<br>*D:\posapp\conf* |
| *spirent_ posapp_ user_ settings.json* | File:<br>*D:\posapp\conf* |

### 1.2.6 Logging files

***Note**: SimGEN running on the Embedded Host allows you to move or delete log files while a scenario is running. Spirent strongly recommends you never move or delete any log file while a scenario is running. You will not be able to recover data from any log file you move or delete*

The following table details logging features in SimGEN running on the GSS7000 Embedded Host.

| Feature | Description |
|---|---|
| **Logging** | SimGEN saves all log files to sub-folders of this folder:<br>*D:/posapp/logs*<br><br>The type of log file determines the sub-folder name, as described below |


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| Feature | Description |
|---|---|
| **Logging - SimGEN** | **You cannot edit the log file location**<br>SimGEN saves log files to sub-folders of a folder bearing the scenario name. The sub-folder name is the time stamp at the start of the run in the format YYYY_MM_DD_HH_MM_SS. For example, *D:/posapp/logs/<scenario_name>/2014_03_24_12_58_21*. This name (12h 58 min 21 seconds on 24 March 2014) is only known after the scenario starts.<br>The remote command **LOG_DIR** - see reference qq), will return the sub-folder name. Notice the remote command **LOG_DIR** will only return the sub-folder name while the scenario is running or before you rewind a scenario that has ended.<br>Log files affected:<br>→ Bulk logging, see ***Bulk logging options*** (page 5-30)<br>→ Remote commands, see ***Remote Command Settings*** (page 5-28)<br>→ UDP data binary logging, in ***Remote Command Settings*****-Ethernet remote commands over TCP/UDP on Port 15650** (page 5-28)<br>→ Output file, in ***Remote Command Settings*****-Output file** (page 5-28)<br>→ General options (as a whole), see ***General Options*** (page 5-15)<br>→ Nav data, see ***General Options*** (page 5-15)<br>→ SP3 orbit data, see ***General Options*** (page 5-15)<br>→ Prior data streaming, see ***General Options*****-dump navigation data** (page 26-32)<br>→ Data streaming binary file, see ***Data Streaming Message Logger*** (page 26-32)<br>→ Quick look logging file, see **Data display and logging file-*Automatic loading*** (page 8-5)<br>→ NMEA logging files (text file directory and CSV file directory), see ***NMEA logging*** (page 8-9)<br>→ NMEA output file, see ***NMEA output*** (page 8-11)<br><br>For log file interfaces that give you an option to set the log file path, SimGEN will display the full path of the log file and disable **Browse**. |
| **Logging - PosApp** | SimGEN saves the PosApp log files to the sub-folder: *D:/posapp/logs/posapp*<br><br>PosApp log files include:<br>→ PosApp message logs - filename format: *PosApp _message_log_<date, time>.txt*<br>→ Remote command settings output file<br>→ Remote command settings log file<br>→ Utility log files (for example, hardware proxy filename format: *PosApp_Hardware_Proxy_message_log _2014_10_18_07_18_34.txt*)<br>→ Engine log files - filename format: *PosApp_en_message_log_<date, time>.txt* |

## 1.2.7 Versions

***Notes**:*

***1)** The Embedded Host uses Windows installed on the C: drive, with SimGEN files installed on the D: drive*

***2)** SimGEN installs certain *.dll files in the Windows folder on the C: drive.*

***3)** For the single line in the file active_version.txt, it is essential you keep the format described. Do not add any characters to, or remove characters from, this line. Do not press return at the end of the last character.*


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This feature lets you use any version of SimGEN installed since the original version.

Spirent supplies the Embedded Host installed with the latest version of SimGEN. Subsequent upgrades are installed in separate folders at *D:\posapp\software\<version>* where *<version>* is a folder whose name reflects the version number using the format *Vw_yy_zz*, where *w*, *y* and *z* are the figures 0 to 9, for example V6_00_01. You can see all versions installed by navigating to *D:\posapp\software* and looking at the folder names.

Notice *D:\posapp\software* also contains the folder *default*, which contains files only for use under guidance by Spirent Global Services engineers. Do not delete this folder or any file within this folder.

To use a previous installation of SimGEN, open the file *D:\posapp\conf\active_version.txt*. This file contains a single line that describes the current version of SimGEN. This is the version of SimGEN that will run when you start SimGEN, for example V6_00_01. Installing an upgrade to SimGEN will automatically edit this file to refer to the upgraded version.

To run a different version of SimGEN, edit this file to refer to the version number you want to run.

For example:

- → You are currently running SimGEN V6_01_02
- → You want to run version V6_01_01
- → Edit the single line in the file *active_version.txt* to read '*V6_01_01'* and save the file.
- → Power cycle your GSS7000
- → When you start SimGEN the version in **Help-About** now refers to V6_01_01

### 1.2.8 USB block devices present when starting your GSS7000

***Note**: USB block devices include flash memory devices, USB DVD drives, USB hard drives, and so on.*

If a USB block device is present in any USB port on your GSS7000 signal generator, it will not correctly boot.

You must remove any USB block device from the signal generator USB ports before starting your GSS7000.

### 1.2.9 Proxies

The GSS7000 Embedded Host requires the following proxies to allow communication between the engine and the GUI:

- → Secure proxy
- → File proxy
- → Hardware proxy

SimGEN uses Windows Scheduled Tasks that Spirent installs in GSS7000 Embedded Host to monitor and control each proxy.

Disabling or removing the proxy Scheduled Tasks from the Windows Scheduled Task Manager will impair the performance of SimGEN, resulting in SimGEN ceasing to run.

### 1.2.10 USB port assignment

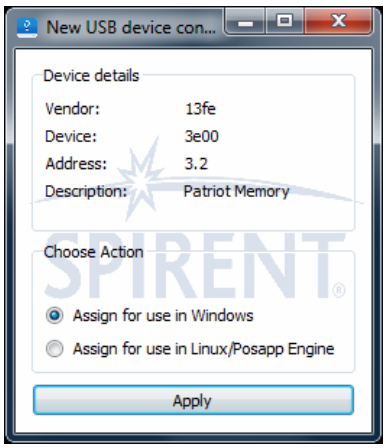
***Notes**:*

***1)** The Embedded Host automatically recognises connection of a USB keyboard and mouse, you do not need to assign these USB devices*

***2)** You must assign USB to RS232 adapters to Linux*

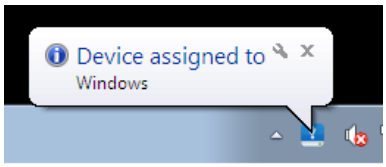
You must assign each available GSS7000 signal generator USB port to either Linux or Window whenever you insert a USB device. The **PosApp USB assign** utility starts automatically when Windows boots on the GSS7000 Embedded Host and displays the **New USB device connected** dialog when you connect a USB device to any GSS7000 USB port:


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Select **Assign for use in Windows** or **Assign for use in Linux/PosApp engine** and then click **Apply**.

The Task Bar shows an appropriate message, for example:




The utility does not store details of any USB device and will always display the **New USB device connected** dialog when you insert a USB device.

### 1.2.11 SimREMOTE commands

When you use a PC to send SimREMOTE commands to the GSS7000, Spirent recommends, wherever possible, you use a direct Ethernet cable connection between the PC you use for to send the SimREMOTE commands and the GSS7000 Ethernet port 'SIMREMOTE'.

Reference qq) describes using SimREMOTE.

## 1.3 Important details for all users of the C50r SimGEN Host

***Note**: Spirent's GSS9000-series signal generators use SimGEN running on a C50r SimGEN Host. The C50r SimGEN Host is completely different from the SimGEN Controller.*

*You can use SimGEN running on a C50r SimGEN Host to run GSS8000-series, and earlier, signal generators.*

Reference uuu) is the system level release notes for the GSS9000 signal generator / C50r SimGEN Host simulator. Refer to this document for details on known issues affecting your system at the time of shipping.

This table details the sections describing changes when using the C50r SimGEN Host and the GSS9000-series signal generators.

| Section | Description |
|---|---|
| ***Licence management*** (page 1-9) | Managing licences, channel banks and constellations on GSS9000-series signal generators |
| ***SimGEN running on the C50r SimGEN Host*** (page 1-9) | Outlines SimGEN running on the C50r SimGEN Host |
| ***File locations*** (page 1-9) | Details the locations of folders for SimGEN installed on a C50r SimGEN Host |
| ***Logging files*** (page 1-11) | Changes to logging files |
| ***Timer card*** (page 1-11) | Describes when you need to use a Timer card |


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### 1.3.1 Licence management

Each GSS9000-series signal generator uses from one to ten channel banks to provide 16 channels per bank of simulated GNSS signals. Your licence sets up the channel bank(s) to generate a single frequency for a specific constellation. SimGEN stores your licences in a “cabinet”.

Upgrading your signal generator to generate a new constellation is as simple as purchasing the relevant licence from Spirent, see ***Updating a licence file*** (page 1-18), you do not need to install new hardware or firmware.

This table gives examples of licence management “rules”:

| Rule | Example (assuming three channel banks and a GPS licence) |
|---|---|
| Each channel bank must be assigned to a single constellation | Bank 1, Bank 2 and Bank 3 are assigned to GPS |
| Each channel bank can only support a single frequency in use by a single constellation | Bank 1 supports GPS L1 or L2 or L5<br>Bank 2 supports GPS L1 or L2 or L5<br>Bank 3 supports GPS L1 or L2 or L5 |
| Channel banks cannot share constellations and/or frequencies | You can separately assign:<br>→ 48 channels to GPS L1 (three banks of 16)<br>→ 48 channels to GPS L5 (three banks of 16)<br>→ 16 channels to GPS L1, plus 16 channels to GPS L5 (two banks of 16) You cannot use the third channel bank for L1 and/or L5<br>→ 16 channels to GPS L1, plus 16 channels to GPS L2, plus 16 channels of GPS L5 (three banks of 16)<br>or other combinations of L1, L2 and L5 |

Depending on the number of channel banks installed in your signal generator and your cabinet of licences, SimGEN calculates all possible operating modes. However, if you have many channel banks and a large cabinet of licences SimGEN may not be able to calculate all possible operating modes. In this case, you must manually manage the operating modes, see **Tools-*Edit GSS9000 operating mode*** (page 5-36).

Reference sss) gives more details on using the GSS9000-series signal generator.

### 1.3.2 SimGEN running on the C50r SimGEN Host

***Note**: A monitor connected to the C50r SimGEN Host DVI port will remain blank for about two minutes before displaying the Windows start-up screen.*

***Windows 7*** (page 1-16) describes the separation of the Graphical User Interface, the GUI, (*PosApp.exe*) from the engine, (*PosApp_engine.exe*) for a previous version of PosApp. SimGEN running on the C50r SimGEN Host uses this separation for the performance of the GSS9000 signal generator, especially for operation at one millisecond update rate. This update rate requires the engine runs on a real-time operating system (Linux), while the GUI remains operating on Windows, which runs on a Virtual Machine.

Separate C50r SimGEN Host processors (one each for engine and GUI) provide adequate performance for calculation of parameters at one millisecond intervals, such as vehicle trajectories for up to 160 simulated satellite channels. The engine calculates the new parameters and sends them to the signal generator in time for the next epoch. The C50r SimGEN Host uses a PCIexpress interface to the GSS9000 signal generator to transfer the large amount of data generated.

### 1.3.3 Using the C50r SimGEN Host on a corporate LAN

For optimum performance of your simulator using one or more GSS9000-series signal generators, Spirent recommends:

→ You do not connect your C50r SimGEN Host to a corporate LAN if that LAN uses the subsets 192.168.25.x or 192.168.26.x

→ Before running any scenario, you disconnect your C50r SimGEN Host from a corporate LAN

Reference sss) describes operating GSSS9000-series signal generators.


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### 1.3.4 File locations

The following tables detail the locations Spirent uses to install SimGEN and its components in the C50r SimGEN Host. The tables also give the equivalent locations for SimGEN files installed on a SimGEN Controller. The tables show the *Positoning Application* folder and any sub-folders, ***Windows 7*** (page 1-16) defines the paths for Windows 7 Professional for Embedded Systems ESD (Virtualisation Only) 32-bit and 64-bit versions that are installed on the C50r SimGEN Host.

**Folders associated with the PosApp gui**

| Folder | Location on C50r SimGEN Host | Location on SimGEN Controller |
|---|---|---|
| PosApp gui | Folder:<br>*D:\posapp\software\<version>\gui* | File:<br>*…\Positioning Application* |
| BeiDou data sets | Folder:<br>*D:\posapp\software\<version>\gui \Beidou_data_sets* | Folder:<br>*…\Positioning Application \BeiDou_data_sets* |
| CAPS data sets | Folder:<br>*D:\posapp\software\<version>\gui \CAPS_data_sets* | Folder:<br>*…\Positioning Application \CAPS_data_sets* |
| Datum files | Folder:<br>*D:\posapp\software\<version>\gui \Datum Files* | Folder:<br>*…\Positioning Application \Datum Files* |
| Documents | Folder:<br>*D:\posapp\software\<version>\gui \Docs* | Folder:<br>*…\Positioning Application \Docs* |
| Firmware upgrade utility | Folder:<br>*D:\posapp\software\<version>\gui \Firmware Upgrade Utility* | Folder:<br>*…\Positioning Application \Firmware Upgrade Utility* |
| Galileo data sets | Folder:<br>*D:\posapp\software\<version>\gui \Galileo_data_sets* | Folder:<br>*…\Positioning Application \Galileo_data_sets* |
| Interface files | Folder:<br>*D:\posapp\software\<version>\gui \interface files* | Folder:<br>*…\Positioning Application \interface files* |
| IRNSS data sets | Folder:<br>*D:\posapp\software\<version>\gui \IRNSS_data_sets* | Folder<br>*…/Positioning Application /IRNSS_data_sets/* |
| Log files | Folder:<br>*D:\posapp\logs* | Folder:<br>*…\Positioning Application \logs* |
| QZ files | Folder:<br>*D:\posapp\software\<version>\gui \QZ files* | Folder:<br>*…\Positioning Application \QZ files* |
| SimAUTO | Executable:<br>*D:\posapp\software\<version>\gui* | Executable:<br>*C:\Program Files \Spirent Communications \Positioning Application* |
| SimCHAN20 | Folder:<br>*D:\posapp\software\<version>\gui \SimCHAN20* | Folder:<br>*…\Positioning Application \SimCHAN20* |
| System data | Folder:<br>*D:\posapp\conf* | Folder:<br>*…\Positioning Application \System data* |


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| Folder | Location on C50r SimGEN Host | Location on SimGEN Controller |
|---|---|---|
| Tools | Folder:<br>*D:\posapp\software\<version>\gui\tools* | Folder:<br>*…\Positioning Application\tools* |
| Utilities | Folder:<br>*D:\posapp\software\<version>\gui* | Folder:<br>*…\Positioning Application* |
| SBAS datasets | Folder<br>*D:\posapp\software\<version>\gui\SBAS_data_sets\<constellation>* | Folder<br>*...\Positioning Application\SBAS_data_sets\<constellation>* |

**Folders associated with the PosApp engine**

| Folder | Location on C50r SimGEN Host | Location on SimGEN Controller |
|---|---|---|
| PosApp engine | Folder:<br>*D:\posapp\software\<version>\engine* | File:<br>*…\Positioning Application* |
| Firmware | Folder:<br>*D:\posapp\software\<version>\firmware* | Not applicable |
| Scenarios | Folder:<br>*D:\posapp\scenarios* | Folder:<br>*…\Positioning Application\Scenarios* |
| Scripts | Folder:<br>*D:\posapp\software\<version>\scripts* | Not applicable |

**Folders associated with Scenarios**

| Folder | Location on C50r SimGEN Host | Location on SimGEN Controller |
|---|---|---|
| Scenarios | Folder:<br>*D:\posapp\scenarios* | Folder:<br>*…\Positioning Application\Scenarios* |
| Shared folder | Folder:<br>*D:\posapp\scenarios\shared* | Folder:<br>*…\Positioning Application\Scenarios\Shared* |

**Files associated with PosApp**

| Files | Location on C50r SimGEN Host | Location on SimGEN Controller |
|---|---|---|
| *lservrc.txt* | Folder:<br>*D:\posapp\conf* | Folder:<br>*…\Positioning Application* |
| *sig_gen.txt* | Folder:<br>*D:\posapp\conf* | Folder:<br>*…\Positioning Application* |
| *spirent_posapp_user_settings.json* | File:<br>*D:\posapp\conf* | File:<br>*…\Positioning Application* |

### 1.3.5 Logging files

***Note**: SimGEN running on the C50r SimGEN Host allows you to move or delete log files while a scenario is running. Spirent strongly recommend you never move or delete any log file while a scenario is running. You will not be able to recover data from any log file you move or delete*

If you use the C50r SimGEN Host and the GSS9000 signal generator, the following table details changes to logging features in SimGEN. Generally, legacy SimGEN users (all users running SimGEN on a SimGEN Controller) will be unaffected.


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| Feature | Description |
|---|---|
| **Logging** | SimGEN running on the C50r SimGEN Host saves all log files to sub-folders of this folder:<br>*D:/posapp/logs*<br><br>The type of log file determines the sub-folder name, as described below |
| **Logging - SimGEN** | **C50r SimGEN Host users cannot edit the log file location**<br>When running on a C50r SimGEN Host, SimGEN saves log files to sub-folders of a folder bearing the scenario name. The sub-folder name is the time stamp at the start of the run in the format YYYY_MM_DD_HH_MM_SS. For example, *D:/posapp/logs/<scenario_name>/2014_03_24_12_58_21*. This name (12h 58 min 21 seconds on 24 March 2014) is only known after the scenario starts.<br>The remote command **LOG_DIR** - see reference qq), will return the sub-folder name. Notice the remote command **LOG_DIR** will only return the sub-folder name while the scenario is running or before you rewind a scenario that has ended.<br>Log files affected:<br>→ Bulk logging, see ***Bulk logging options*** (page 5-30)<br>→ Remote commands, see ***Remote Command Settings*** (page 5-28)<br>→ UDP data binary logging, in ***Remote Command Settings*****-Ethernet remote commands over TCP/UDP on Port 15650** (page 5-28)<br>→ Output file, in ***Remote Command Settings*****-Output file** (page 5-28)<br>→ General options (as a whole), see ***General Options*** (page 5-15)<br>→ Nav data, see ***General Options*** (page 5-15)<br>→ SP3 orbit data, see ***General Options*** (page 5-15)<br>→ Prior data streaming, see ***General Options*****-dump navigation data** (page 26-32)<br>→ Data streaming binary file, see ***Data Streaming Message Logger*** (page 26-32)<br>→ Quick look logging file, see **Data display and logging file-*Automatic loading*** (page 8-5)<br>→ NMEA logging files (text file directory and CSV file directory), see ***NMEA logging*** (page 8-9)<br>→ NMEA output file, see ***NMEA output*** (page 8-11)<br><br>For log file interfaces that give you an option to set the log file path, SimGEN running on the C50r SimGEN Host will display the full path of the log file and disable **Browse**.<br>SimGEN running on the C50r SimGEN Host does not update scenario files with the log file paths *D:/posapp/logs/…* For example:<br>→ You create a scenario using SimGEN running on a SimGEN Controller and set the bulk logging file path to *C:/Bulklog*.<br>→ You then open this scenario in SimGEN running on a C50r SimGEN Host and edit, save and run the scenario. SimGEN saves the log files to the location *D:/posapp/logs/… ,* as detailed above.<br>→ Now you open the scenario on a SimGEN Controller - the bulk logging path remains as *C:/Bulklog*.<br><br>**Legacy SimGEN Controller users are unaffected**<br>If you run SimGEN on a SimGEN Controller you can still set the log file path by clicking **Browse** and navigating to a new log file location. |


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| Feature | Description |
|---|---|
| **Logging - PosApp** | SimGEN running on the C50r SimGEN Host saves the PosApp log files to the sub-folder: *D:/posapp/logs/posapp*<br><br>PosApp log files include:<br>→ PosApp message logs - filename format: *PosApp _message_log_<date, time>.txt*<br>→ Remote command settings output file<br>→ Remote command settings log file<br>→ Utility log files (for example, hardware proxy filename format: *PosApp_Hardware_Proxy_message_log _2014_10_18_07_18_34.txt*)<br>→ Engine log files - filename format: *PosApp_en_message_log_<date, time>.txt* |

### 1.3.6 Versions

***Notes**:*

***1)** The C50r SimGEN Host uses Windows installed on the C: drive, with the SimGEN files installed on the D: drive*

***2)** SimGEN install certain *.dll files in the Windows folder on the C: drive. In certain cases, you may also need to change these files to run an earlier verison of SimGEN. Contact Spirent Global Services for assistance*

***3)** For the single line in the file active_version.txt, it is essential you keep the format described. Do not add any characters to, or remove characters from, this line. Do not press return at the end of the last character*

This feature lets you use any version of SimGEN installed since the original version.

Spirent supplies the C50r SimGEN Host installed with the latest version of SimGEN. Subsequent upgrades are installed in separate folders at *D:\posapp\software\<version>* where *<version>* is a folder whose name reflects the version number using the format *Vw_yy_zz*, where *w*, *y* and *z* are the figures 0 to 9, for example V5_00_01.
You can see all versions installed by navigating to *D:\posapp\software* and looking at the folder names.

Notice *D:\posapp\software* also contains the folder *default*, which contains files only for use under guidance by Spirent Global Services engineers. Do not delete this folder or any file within this folder.

To use a previous installation of SimGEN, open the file *D:\posapp\conf\active_version.txt*. This file contains a single line that describes the current version of SimGEN. This is the version of SimGEN that will run when you start SimGEN, for example V5_00_01. Installing an upgrade to SimGEN will automatically edit this file to refer to the upgraded version.

To run a different version of SimGEN, edit this file to refer to the version number you want to run.

For example:

→ You are currently running SimGEN V5_03_01

→ You want to run version V5_02_03

→ Edit the single line in the file *active_version.txt* to read '*V5_02_03'* and save the file.

→ Power cycle the C50r SimGEN Host

→ When you start SimGEN the version in ***Help*-About** (page 5-36) now refers to V5_02_03

### 1.3.7 Timer card

***Note**: GSS9000-series signal generators using SimGEN on the C50r SimGEN Host do not use a Timer card.*

Only available for GSS8000-series signal generators using SimGEN running on a SimGEN Controller.

### 1.3.8 USB block devices present on boot

***Note**: USB block devices include flash memory devices, USB DVD drives, USB hard drives, and so on.*

If a USB block device is present in any USB port, the C50r SimGEN Host will not correctly boot.


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You must remove any USB block device from the C50r SimGEN Host USB ports before booting the C50r SimGEN Host.

This requirement does not apply to USB adaptors, such as USB to RS232 adaptors.

### 1.3.9 Proxies

The C50r SimGEN Host requires these proxies to allow communication between the engine and the GUI:

- Secure proxy
- File proxy
- Hardware proxy

SimGEN uses Windows Scheduled Tasks that Spirent installs in Windows 7 Professional for Embedded Systems ESD (Virtualisation Only) on the C50r SimGEN Host to monitor and control each proxy.

Disabling or removing the proxy Scheduled Tasks from the Windows Scheduled Task Manager will impair the performance of SimGEN, resulting in SimGEN ceasing to run.

### 1.3.10 SimREMOTE commands

When you use a PC to send SimREMOTE commands to the C50r SimGEN Host, Spirent recommends, wherever possible, you use a direct Ethernet cable connection between the PC you use to send the SimREMOTE commands and the C50r SimGEN Host Ethernet port 'REMOTE'.

Reference qq) describes using SimREMOTE.

### 1.3.11 Replacing the C50r SimGEN Host BIOS battery



**SAFETY WARNING**
**Risk of explosion if battery is replaced with an incorrect type**

**Recycle batteries where possible**

**Dispose of used batteries in accordance with local and national environmental regulations**



**SAFETY WARNING**

**Do not operate your C50r SimGEN Host with any panel removed**

**To completely isolate mains power remove the plug from the mains outlet. The mains outlet should be close to the equipment in use and readily accessible by the user**

***Notes***:

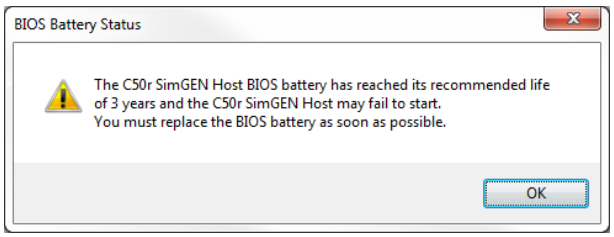
***1)*** *Spirent estimates the life of the C50r SimGEN Host BIOS battery to be no more than three years and recommend you replace the BIOS battery at intervals not exceeding three years.*
*If the BIOS battery fails, your C50r SimGEN Host will be unable to operate the Virtual Machine, see* ***SimGEN running on the C50r SimGEN Host*** *page (1-9), which will render your C50r SimGEN Host and your GSS9000-series signal generator unusable.*

***2)*** *SimGEN displays a warning message in the* ***System Message*** *window when the BIOS battery has 60 days, or fewer, remaining to the third anniversary of the installation date of the BIOS battery, see* ***BIOS Battery Status*** *page (26-29)*

***3)*** *Contact* ***Spirent Global Services*** *for details on replacing the BIOS battery*

Spirent estimates the life of the C50r SimGEN Host BIOS battery to be no more than three years, and recommend you replace the BIOS battery at intervals not exceeding three years. On the third anniversary of the installation date of the BIOS battery, SimGEN automatically displays this dialog (the **System Messages** window also displays the same text):


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## 1.4 PosApp Version 4 to Version 5

PosApp 4 is a major rework of the long-standing PosApp/SimGEN code base, separating the Graphical User Interface, the GUI, (*PosApp.exe*) from the simulation engine, the engine, (*PosApp_engine.exe*) responsible for the simulation calculations and communication with the signal generator.

Separating the GUI from the engine offers potential advantages for the future:

- Integration of the engine with other applications, either Spirent or third-party
- Running the engine on different platforms, such as real-time platforms for higher performance
- Using alternative GUIs tailored to specific applications, or on different platforms

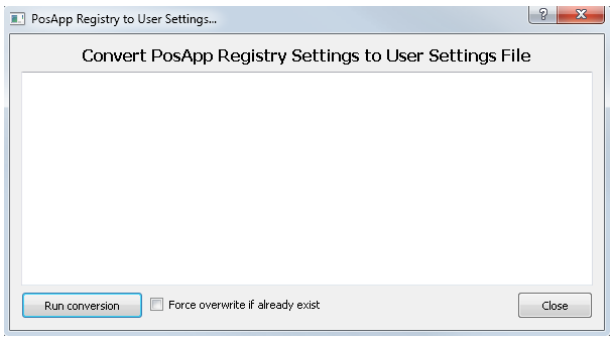
Most existing SimGEN users will experience only minor changes when using PosApp.

### 1.4.1 User settings file

In previous versions of PosApp (and SimGEN), configuration information, preferences and user settings were saved in the Windows Registry. PosApp version 4 onwards now saves this information in a 'user settings' file *spirent_posapp_user_settings.json* located in the PosApp installation folder.

After installing PosApp, the Spirent utility *Registry_to_user_settings.exe* runs once the first time each user runs PosApp. The utility checks if a user settings file entry for that user exists and, if missing, creates the entry. This process occurs each time a new user runs PosApp for the first time. Notice all user settings are stored in a single user settings file.

The figure below shows the utility:

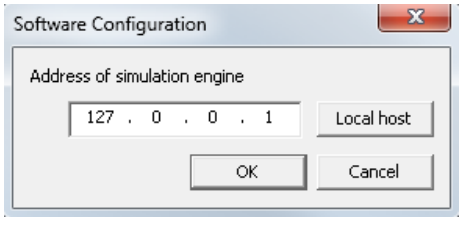



The conversion process is not automatic; you must begin the process by clicking **Run Conversion**. You can force the utility to overwrite the user setting file by selecting **Force overwrite if already exist**.

If necessary, you can manually run this utility by navigating to the PosApp installation folder and double-clicking *Registry_to_user_settings.exe*.

### 1.4.2 Changing Software Configuration

Separating the GUI from the simulation engine gives you the ability to run the GUI and the simulation engine on different PCs. When you run PosApp for the first time (including upgrades), you will see the **Software Configuration** dialog:



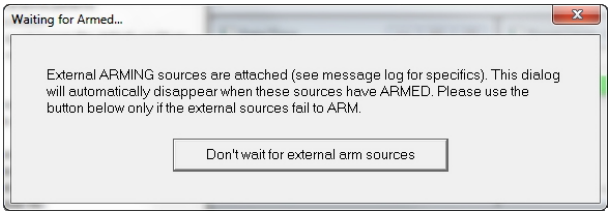

**Menus-*Edit GSS9000 operating mode*** (page 5-36) details using this dialog.


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### 1.4.3 Arming

***Note**: This section only applies if you connect other software systems to the SimGEN Controller of your simulator using the SimREMOTE interface - see reference qq), and that software has registered as an external arming source for SimGEN.*

When using SimGEN with an external arming source, you may see the **Waiting for Armed…** dialog:




This dialog appears while SimGEN is arming. It informs you SimGEN is waiting for all registered external arming sources to ARM. The external software informs SimGEN it has successfully ARMED using the remote command "EXTERNAL_ARMED".

SimGEN closes the **Waiting for Armed…** dialog when all external armed sources have responded with EXTERNAL_ARMED". SimGEN then starts the run.

If you do not want to wait for the external arming sources to ARM SimGEN, click **Don't wait for external arm sources** and SimGEN will continue and run the scenario.

For more information on this sequence, see the remote command REGISTER_EXTERNAL_ARM in reference qq).

## 1.5 Windows 7 and the SimGEN Controller

***Note**: PosApp version 4.04 onwards only supports Windows 7 (32- and 64- bit)*

For simulators running PosApp version 3-00 onwards, Spirent will install and configure the Windows 7 Operating System on the SimGEN Controller, as follows:

- The default installation folder for Spirent software running on 32-bit Windows 7 is: *C:\Program Files\Spirent Communications\Positioning Application*.
- The default installation folder for Spirent software running on 64-bit Windows 7 is: *C:\Program Files (x86)\Spirent Communications\Positioning Application*.

Before using a user-supplied PC running the Windows 7 Operating System as a SimGEN Controller, Spirent recommends you set up the Windows 7 PC following reference ppp). Contact Spirent Global Services (page 28-1) for more details on using Windows 7 with your existing Spirent simulator.

This document refers to 32-bit Windows 7 file locations (typically in the folder *C:\Program Files*\...). Users of 64-bit Windows 7need to be aware of the change in the default folder name (*C:\Program Files (x86)*\...).

## 1.6 Important notice for all SimGEN users updating to version 2.90 up to version 5.00

***Note**: From Positioning Application version 2.90 onwards, Spirent's Software licence, reference aaa), includes the following "No hardware" mode condition in section 3) Copies: "… a) controlling the Equipment with which it was supplied or b) in no-hardware mode for which a separate specific licence key will be issued." This licence condition lets you install and use a copy of the Software, in "No hardware" mode, on a separate PC. Spirent will issue you with a complimentary "No hardware" licence key, locked to the characteristics of a single PC. Before version 2-90, the licence conditions for Spirent Software prevented you from installing Spirent Software on additional computers.*

From version 2-90 onwards:

- Spirent supplies a single executable, *PosApp.exe* (Spirent Positioning Application), which functions as SimGEN, SimREPLAYplus or SimREPLAY, depending on your software licence.
- For each system you are upgrading, you cannot run SimGEN, SimREPLAY or SimREPLAYplus without a valid software licence. Spirent supply appropriate licences as part of the Installation package.


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Spirent locks each software licence to the serial number of your attached signal generator (or the master signal generator for simulators with more than one signal generator).

There is no change to simulator features using a Spirent dongle - you will still need to insert your dongle in a USB port on the SimGEN Controller to enable these features.

The following section details installation and obtaining additional “No hardware” licences.

### 1.6.1 Installation

***Notes**:*

***1)** Installing Spirent’s Positioning Application retains your previous SimGEN, SimREPLAY or SimREPLAYplus application and your customer-specific files and scenarios, so you can run the older application at any time.*

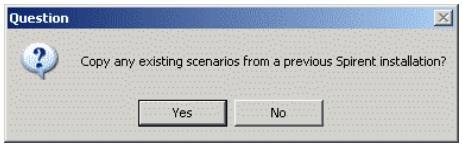
***2)** Spirent’s licencing system locks the software to a specific PC by using characteristics of the PC to generate the software licence. You must run the Positioning Application executable on the PC you wish to use, especially if you want to use Spirent’s software in “No hardware” mode.*

By default, Spirent’s installation program loads the Positioning Application executable, *PosApp.exe*, to the folder *C:\Program Files\Spirent Communications\Positioning Application*, whereas previously, Spirent’s SimGEN, SimREPLAY and SimREPLAYplus executable files were loaded in *C:\Program Files\Spirent Communications\[executable name]*.

During a first-time installation of Spirent’s Positioning Application, the installer searches (in the order SimGEN, SimREPLAYplus then SimREPLAY) for previous installations of Spirent software. You have the option of copying your customer-specific settings (and, optionally, your scenarios) from the first application found to the Positioning Application folder.

### 1.6.2 Performing a first-time installation

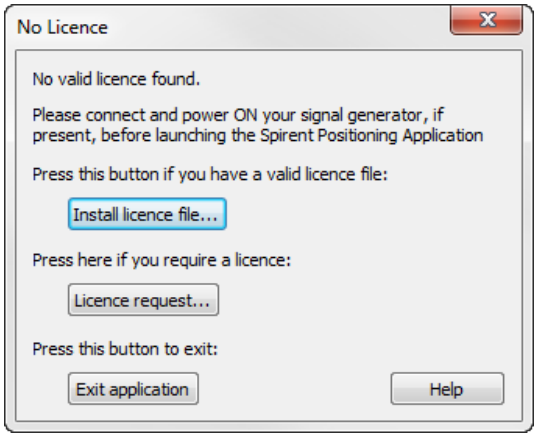
- Ensure you have available a licence file. Spirent keys the licence file to the serial number of the signal generator to which you connect your SimGEN Controller
- Connect your SimGEN Controller to ac power and turn it on
- Using the Spirent Positioning Application installation CD, or the web installation package, proceed with the standard installation, responding to the prompts as appropriate
- You will see this prompt:




- To copy your files, click **Yes**. The installer copies your customer-specific files and settings, and optionally your scenarios, to the new *Positioning Application* folder
- Click **No** to keep your files in their original locations. You may want to do this if you have many scenario files or large data files included with the scenarios
- In this case, in the **Select scenario** dialog you must navigate to the previous application’s *Scenarios* folder. You only need do this once, as this folder will become the default folder for future scenarios
- The installer does not delete your previous SimGEN (or SimREPLAY / SimREPLAYplus) installation and it retains your customer-specific files and scenarios, should you wish to run the older version
- Following successful completion of the installation, you will see a Positioning Application icon on your desktop (you may need to re-boot the SimGEN Controller before this icon appears as the “SimGEN" icon)
- Assuming you are running the Positioning Application for the first time, you will need to verify your licence against the signal generator serial number. First, connect the signal generator to AC power, connect the signal generator to the SimGEN Controller and turn on the signal generator. Then:
- On the SimGEN Controller, double-click the **Positioning Application** icon to run the Positioning Application


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→ You will see the **No licence** dialog (notice this dialog always appears in a SimREPLAY window) :



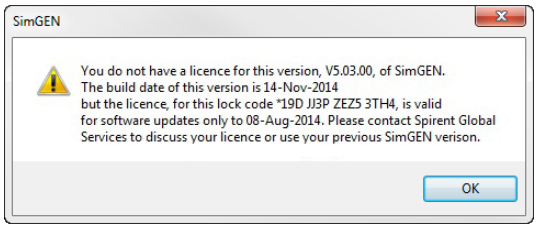

→ Click **Install licence file** and navigate to the licence file that Spirent supplies

→ After you select the licence file, a dialog requests you confirm installation of the licence file

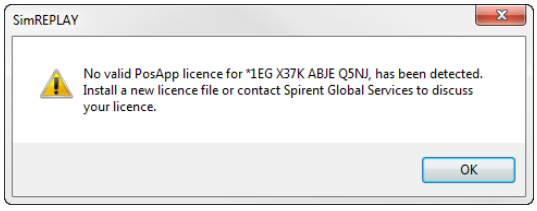
→ After you confirm the installation, click **OK** to restart SimGEN

This completes the installation

SimGEN displays this error message if you have a timed licence that has expired, notice the message refers to the lock code of your C50r SimGEN Host (GSS9000-series signal generators), Embedded Host (GSS7000 signal generators) or SimGEN Controller (GSS8000-series, and earlier, signal generators):




SimGEN displays this error message if SimGEN cannot find a valid licence, notice the message refers to the lock code of your C50r SimGEN Host (GSS9000-series signal generators), Embedded Host (GSS7000 signal generators) or SimGEN Controller (GSS8000-series, and earlier, signal generators):




The Positioning Application installs the licence file to the *Positioning Application* folder using the name *lservrc.txt* and saves the licence file, using its original name, to the licence history folder…*Positioning Application\licence history*.
If you delete *lservrc.txt* you will need to re-install your Positioning Application licence to the *Positioning Application* folder.

If you have questions concerning this procedure, contact Spirent Global Services at: support@spirent.com

### 1.6.3 Updating a licence file

The Positioning Application installs the licence file, *lservrc.txt*, to the *Positioning Application* folder and saves the licence file, using its original name, to the licence history folder…*Positioning Application\licence history*.

If you want to upgrade to a feature that requires a licence, contact Spirent Global Services who will assist you in your licence application.

When you receive your new licence file from Spirent, Spirent recommends you store the file in a safe location.

To install the file:


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- First, run PosApp.
- Click **Tools-Install licence file…**
- Navigate to the location of your new licence file.
- Click **Open**
- SimGEN will ask if you want to install the licence file. Click **Yes**
- SimGEN advises you must restart to use the new licence. Click **OK**
- SimGEN restarts.
- Check you can see the features your new licence enables

### 1.6.4 Licences for “No hardware” mode

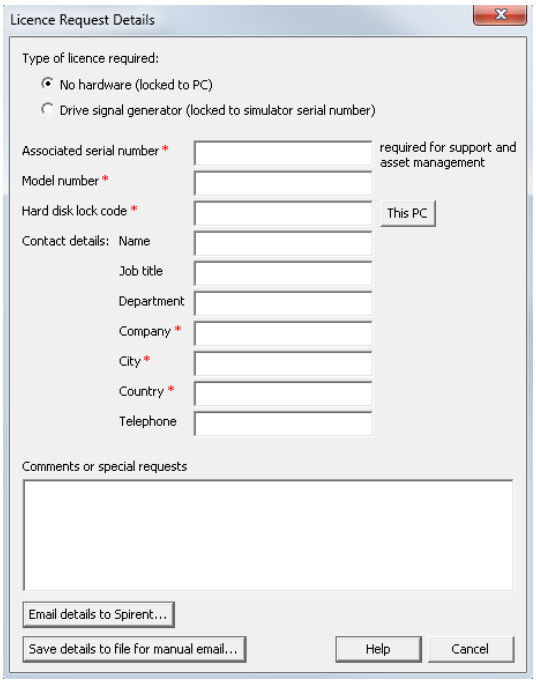
***Notes**:*

***1)** To enable support and asset management, Spirent associates every “No hardware” licence with a full simulator licence. This lets Spirent control the issue of complimentary “No hardware” licences.*

***2)** Since Spirent locks the “No hardware” licence to characteristics of the PC, It is important you run the Positioning Application executable on the PC you want to use in “No hardware” mode.*

***3)** The Positioning Application install CD Spirent provides with the C50r SimGEN Host is not compatible with standard PCs. You will require a Windows version of the installation package. Please contact Spirent Global Services*

To obtain a “No hardware” licence, follow the previous section and run the Positioning Application executable, *PosApp.exe*, on the PC you want to use. When you get to the step “You will see the **No licence** dialog:”, click **Licence request** and complete the **Licence Request Details** dialog:




For a “No hardware” licence, ensure you select **No hardware (locked to PC)**. In **Associated serial number,** enter the serial number of the signal generator with which this request is associated (see Notes above). Click **This PC** to generate a code unique to your PC. Spirent uses this unique PC code to generate the “No hardware” licence key (reminder: you will not be able to use this licence key to run SimGEN in “No hardware” mode on any other PC).

Click **Email details to Spirent…** to send a licence request e-mail to Spirent.

If your C50r SimGEN Host (or SimGEN Controller) does not have an internet connection, click **Save details to file for manual email…**. You can then e-mail the licence request to Spirent Global Services at this e-mail address: licence_pt@spirent.com.


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### 1.6.5 Spirent software licence and Support Agreement expiry message

If you have Spirent support, SimGEN will display a message when you have 90-days and 30-days remaining on your software licence and Support Agreement, for example:




SimGEN displays a similar message if you only have a software licence.

Clicking **Licence request…** opens the **Licence Request Details** dialog, see ***Licences for "No hardware" mode*** (page 1-19), with the **Associated serial number**, **Model number** and **Hard disk lock code** areas populated.

Complete the remaining area and click **Email details to Spirent…** to send the support licence request to Spirent.

If your C50r SimGEN Host (or SimGEN Controller) does not have an internet connection, in the **Licence Request Details** dialog, click **Save details to file for manual email…**. You can then e-mail the support licence request to Spirent Global Services at this e-mail address: licence_pt@spirent.com.

## 1.7 Licenced features

***Note**: Spirent is moving to using licence files for all licenced features. This means Spirent can issue you with a licence by e-mail, rather than shipping a dongle. If you currently use a dongle to provide access to a licenced feature, your dongle will continue to provide this access until Spirent issues you with an appropriate licence file.*

Up to SimGEN version 2-90, Spirent used a USB dongle to control access to certain SimGEN features. From SimGEN version 2-91 onwards, Spirent is introducing file, or software, licencing for some of these features.

This document identifies features that need a licence with the text ***Licenced feature:*** followed by a description, such as "*You will need a licence to use this feature. Contact Spirent for licencing details*".

You do not need additional documentation to use the licenced feature; this document describes the parameters in the licenced feature.

The table below shows all licenced features in SimGEN and shows the licence type as either File or Dongle. Spirent will provide you with the appropriate licence file or dongle:

| Feature | Licence type | See |
|---|---|---|
| All ULTS and PLTS details | File | ***PLTS and ULTS - NovAtel message emulation*** |
| All Quasi-Zenith details | File | ***Quasi-Zenith constellation editor*** (page 13-1) |
| All IRNSS details | File | ***IRNSS constellation editor*** (page 16-1) |
| All BeiDou details | File | ***BeiDou constellation editor*** (page 18-1) |
| All CAPS details | File | ***CAPS constellation editor*** (page 17-1) |
| Individual INS Models | File | ***INS error model*** (page 22-1) |
| Internal IMU | File / Dongle | ***INS error model*** |
| Data streaming - M-Code | Dongle | ***Data streaming definition file*** (page 8-6) |
| Data streaming - Legacy nav | Dongle | ***Data streaming definition file*** |
| Data streaming - Almanac and Ephemeris | Dongle | ***Data streaming definition file*** |


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## 1.8 Timed licences

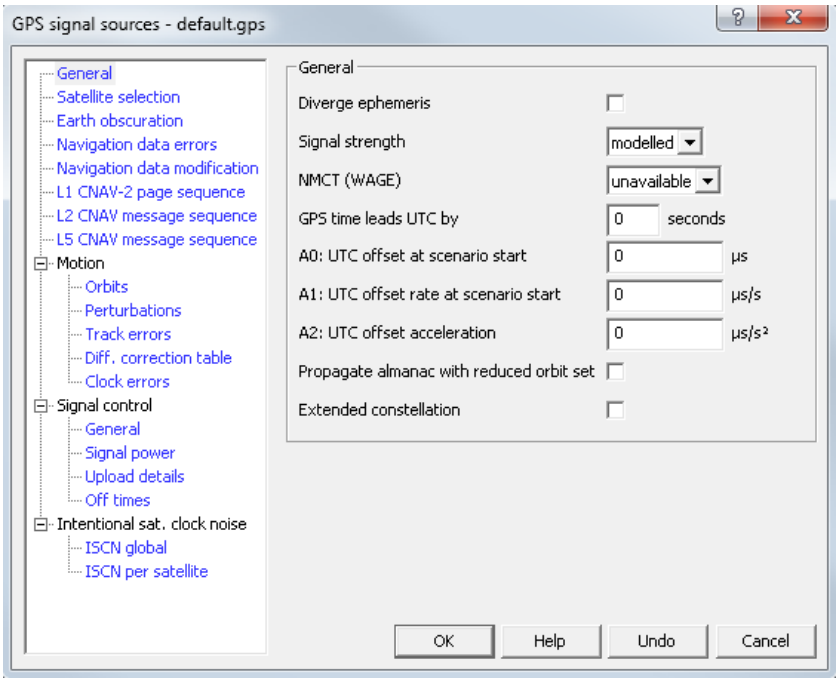
If you have a timed licence (a licence that expires on a specific date) contact ***Spirent Global Services*** before the date on which your licence expires. Be aware that PosApp monitors the C50r SimGEN Host clock to ensure validity of timed licences and PosApp may not operate if you change the C50r SimGEN Host clock.

## 1.9 Document conventions

This document uses the following formatting:

| Format | Description |
|---|---|
| ***INS error model*** (page 22-1) | Hyperlinked section name, click to go to this section or chapter<br>Bold text preceding the hyperlink gives the section location.<br>A hyperlink alone refers to a location in the current chapter.<br>The printed document and pdf include a page number |
| This figure (or This table) | Hyperlink to a figure or table (with a page number) |
| **Clear** | Button name (with extra description to avoid ambiguity) |
| **Edit** | Menu item (with extra description to avoid ambiguity) |
| *SimGEN.exe* | Filename |
| ***Note**: Insert the dongle* | Important information |
| *"Text"* | Text entered from keyboard |
| **Signal control - General** | Title of dialog or window (with extra description to avoid ambiguity) |
| **Signal definition** | Title of area within a dialog or window |
| *default_vx-yy* | Default filename, where *yy is* the version number of major release *x*, followed by relevant extension |

Where you can specify a parameter in a dialog, this document gives a screenshot followed by a table listing the parameters in the dialog from top-to-bottom. The table gives the parameter name followed by a description and the parameter unit, its allowable range and the default value. For example, this figure shows the **GPS constellation Signal sources-General** dialog:




The example below shows some of the parameters in the screenshot and the format in use.

| | | | |
|---|---|---|---|
| **Diverge Ephemeris** | Deselect (default): The ephemeris transmitted in the navigation data for each satellite accurately describes the simulated satellite orbit.<br><br>Select: Simulates degradation in ranging accuracy by applying errors to the ephemeris transmitted in the navigation data for each satellite. The degradation is in accordance with the Graceful Degradation of Accuracy curve in reference a). | | |
| ***Note**: The position SimGEN simulates remains that you specify in the constellation editor.* | | | |
| **Signal strength** | choose from: | | |
| **Modelled** | Modifies satellite signal-levels as a function of the satellite to GPS receiver antenna distance, relative to the base level you specify in Signal control-Signal power.<br>The signal-level varies in proportion to 1/(distance)$^2$. | | |
| **GPS** | Fixes the signal-level at the level you specify in the constellation's Signal Power dialog.<br>Settings in ***Receive and transmit antennas*** (page 23-1) will modify this signal level | | |
| **GPS time leads UTC by** | Specifies the GPS (time) to UTC (Universal Time Co-ordinated) offset as an integer number of seconds.<br>SimGEN always displays GPS time. | | |
| | Units: seconds | Range: -128 to +127 s | Default: 0 |
| For example, you use a GPS to UTC offset of 12 seconds. When you connect a GPS receiver set to display UTC time, to your signal generator, you will see the receiver time display offset by 12 seconds from the simulation time. | | | |

## 1.10 Signal generator resolution and SimGEN resolution

Generally, SimGEN has better resolution of parameters such as power-level than the signal generator it is controlling. Typically, the signal generator can resolve power level to one tenth of a decibel (dB). The latest issue of the product specification for your signal generator contains resolution details.

## 1.11 Referenced documents

This section details external documents, including GNSS ICD to which this document refers; Spirent documents to which this document refers and suggests documents for further reading.

### 1.11.1 External Interface Control Documents referenced in this user manual

***Note**: Contact Spirent for details on the compliance status of these ICDs*

a) NATO Standard Agreement STANAG 4294 Issue 1.
b) IS-GPS-200F Navstar GPS Space Segment/Navigation User Segment Interfaces (21 September 2011).
c) ICD-GPS-705 B Navstar GPS Space Segment/User Segment L5 Interface (21 September 2011).
d) RTCA/DO-229D 13 Dec 2006: Minimum operational performance standards for Global Positioning System/Wide Area Augmentation System Airborne Equipment.
e) GLONASS ICD 4 Oct 1995 (Co-ordination Information Centre, Moscow).
f) RTCA DO-246A and B: GNSS Based precision Approach Local Area Augmentation System (LAAS)-Signal-In-Space ICD.
g) RTCA-DO-246C: GNSS Based precision Approach Local Area Augmentation System (LAAS)-Signal-In-Space ICD (Apr 2005).
h) RTCA-DO-246D: GNSS Based precision Approach Local Area Augmentation System (LAAS)-Signal-In-Space ICD (Dec 2008)
i) SBAS RINEX file format - see ftp://igscb.jpl.nasa.gov/igscb/data/format/geo_sbas.txt
j) RTCM 10402.2 Recommended standards for differential GNSS (Global Navigation Satellite Systems) service, Version 2.2.
k) RTCM 10402.3 Recommended standards for differential GNSS (Global Navigation Satellite Systems) service, Version 2.3.
l) Tropospheric correction reference model in document RTCA/DO-229 January 16, 1996.
m) Tropospheric correction reference model in document RTCA/DO-229 June 8, 1998.
n) Stanag 4572, Appendix 2, section 3.2.4.1.
o) ICD-GPS-200D 30.3.3.1.1.3 to 30.3.3.1.1.4.
p) Tropospheric correction reference model in document RTCA/DO-229 December 13, 2006.
q) IS-QZSS-16-E November 2014
r) Galileo_SISICD V13.2 June 2009


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s) RTCM 10403.1 Differential GNSS (Global Navigation Satellite Systems) Services, Version 3.1
t) RTCM 10403.2 Differential GNSS (Global Navigation Satellite Systems) Services, Version 3.2
u) IS-GPS-800B Navstar GPS Space Segment/User Segment L1C Interface (21 September 2011).
v) IRNSS SIS ICD Version 1.1 (April 2011)
w) Galileo OSSIS ICD Issue 1.1 September 2010
x) NAOC Requirements for CAPS Simulator - Document received by Spirent 1st July 2010
y) BeiDou Navigation Satellite Sytem SIS ICD, Open Service Signal B1I (Version 1.0). China Satellite Navigation Office, December 2012
z) International GPS Service - Extended Standard Product 3 Format Version "c" (IGS-SP3c) S. HIlla National Geodetic Survey, National Ocean Service, NOAA, Silver Spring, MD, USA (17 August 2010)
aa) BeiDou Navigation Satellite Sytem SIS ICD, Open Service Signal (Version 2.0). China Satellite Navigation Office, December 2013
bb) IS-GPS-200H Navstar GPS Space Segment/Navigation User Interfaces (24 Sept 2014)
cc) IS-GPS-705D Navstar GPS Space Segment/User Segment L5 Interface (24 Sept 2014)
dd) Radiosignals and digital data structure of GLONASS Wide Area Augmentation System, System of Differential Correction and Monitoring (Edition 1) 2012
ee) IS-GPS-800D Navstar GPS Space Segment / User Segment L1C Interface

### 1.11.2 External Documents referenced in this user manual

ff) Proposed Models and Methods for Verification Testing of A-GPS Mobile Phones: Technical Paper first published at ION GPS 2002, Portland Oregon.
gg) Transformation Parameters Between PZ-90 and WGS-84, U. Rossbach, H. Habrish, N. Zarraoa, presented at the GPS Conference of the Institute of Navigation 1996.
hh) Tropospheric Model 2 by Bean, B.R. and Dutton, E.J., Radio Meteorology, Dover Publications, New York, 1966.
ii) Rinex version 2.10 - download from http://igscb.jpl.nasa.gov/igscb/data/format/rinex210.txt
jj) Rinex version 3.00 - download from http://igscb.jpl.nasa.gov/igscb/data/format/rinex301.pdf
kk) Simulating Ionosphere-Induced Scintillation for Testing GPS Receiver Phase Tracking Loops, Humphreys et al., IEEE Journal of Selected Topics in Signal Processing, 3, No 4, pp 707 - 715.
ll) Using GLONASS in Combined GNSS Receivers: Current Status, presented at IONGNSS 18th International Meeting of the Satellite Division, 13-16 September 2005, Long Beach CA

### 1.11.3 Spirent documents referenced in this user manual

mm) DGP00703AAA: Signal Generator Hardware User Manual.
nn) DGP00736AAA: ISS using SimGEN.
oo) DGP00818AAA: SimINERTIAL Manual.
pp) DGP00821AAA: SimDATA Manual.
qq) DGP00792AAA: SimREMOTE Manual.
rr) DGP00822AAA: Baro User Manual.
ss) DGP00748AAA: SimGEN CD Release Notes.
tt) DGP01057AAA: Technical description of the space-stabilized terrestrial navigation (INS model).
uu) DGP00782AAA: SimMCODE User Manual.
vv) DGP00921AAA: M-code SDS Hardware and Software user manual
ww) DGP00856AAA: Galileo appendix (authorised users) for SimGEN.
xx) DGP01074AAA: GSS6700, SimREPLAY and SimREPLAYplus user manual.
yy) DGP000864AAA: SimPRS User Manual.
zz) DGP001102AAA: SimPROCESS User Manual.
aaa) DGP000956AAA: Spirent software licence.
bbb) DGP001244AAA: SimSENSOR appendix for SimGEN
ccc) DAN006-TM: Simulator to receiver RF connection.
ddd) DKB044: Hints And Tips To Aid First-time Receiver Navigation.
eee) DKB124: SimGEN Crashes.
fff) DKB135: Issues Installing A Newer SimGEN Version.
ggg) DGP01062AAA: Vehicle Reference Frames and Vehicle Motion Handling in SimGEN Software.
hhh) DGP01045AAA: Check Motion Utility User Guide.
iii) DGP01119AAA: WiFi Positioning Simulator User Manual.
jjj) DGP01251AAA: SimCHAN software User Manual.
kkk) DCS0024A: Updating Simulator Compact Flash Cards.
lll) DCS0030A: Upgrading Intel Processor Firmware.
mmm) DCS0032A: Upgrading Small Chassis Simulator Firmware.
nnn) DCS0038A: Updating GSS6300 GSS6700 Simulator Firmware or FPGA.
ooo) DCS0038B: Ugrading GSS6300 GSS6700 Simulator Features.
ppp) DCS0036D: Configuring a Windows 7 PC as a Spirent System Controller.
qqq) DCS0037A and B: Rate Table Calibration Procedures.


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rrr) DSH0075AAA: Software High Level Design Facilities for GPS Assistance Data (ULTS System).
sss) DGP01335AAA: GSS9000-series Signal Generator Hardware Manual.
ttt) DGP01348AAA: Install GSS9000 FPGA Module.
uuu) 77-005442: GSS9000 System Level Release Notes – Known Issues.
vvv) DGP01361AAA: Setup Guidelines for SimREMOTE with a GSS9000.
www) DGP01446AAA: SimTEST User Manual.
xxx) DGP01430AAA: GSS7000 Signal Generator User Manual.
yyy) DGP01449AAA: GSS7000, GSS6700 and SimREPLAYplus user manual.
zzz) DAN017-TM SimROUTE Road-Matched Trajectory Generation Tool.

### 1.11.4 Documents for further reading

aaaa) GLONASS Interface Control Document (rev. 1995), Coordinational Scientific Information Centre of the Russian Space Forces 1995.
bbbb) PIRN-200C-007 Rev B L2 Civil Proposed Interface Revision Notice November 8th, 2002.
cccc) NMEA 0183- Standard for Interfacing Marine Electronic Devices Version 2.30 March 1, 1998.
dddd) NMEA 0183 Version 4.10 - available to purchase from http://www.nmea.org/
eeee) GNSS Based Precision Approach Local Area Augmentation System (LAAS) Signal-in-Space Interface Control Document (ICD) RTCA/DO-246B.
ffff) Integrated Use of GPS and GLONASS: Transformation Between WGS-84 and PZ-90, P.N. Misra, R.I. Abbot, and E.M. Gaposchkin, Lincoln Laboratory, Massachusetts Institute of Technology.
gggg) Co-ordinate Systems used in Geodesy: Basic Definitions and Concepts, T. Soler and L.D. Hothem, Journal of Surveying Engineering, 114, 2, 1988 pp. 84-97.
hhhh) GPS Satellite Surveying 1995, 2nd Edition, Alfred Leick, John Wiley and Sons, New York, p 476.
iiii) Precision GPS Surveying after Y-code. Ashajee & Lorenz. Proc. ION-GPS-92. Optimised Processing of Signals for Enhanced Cross-correlation in a Satellite Positioning Receiver. Lennen, G.R. US Patent 5,621,416.
jjjj) https://developers.google.com/kml/documentation/kml_tut (accessed March 2013) a tutorial on using KML and gives links to further information on KML

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The object code form of an Application may incorporate material from a header file that is part of the Library. You may convey such object code under terms of your choice, provided that, if the incorporated material is not limited to numerical parameters, data structure layouts and accessors, or small macros, inline functions and templates (ten or fewer lines in length), you do both of the following:

a) Give prominent notice with each copy of the object code that the Library is used in it and that the Library and its use are covered by this License.

b) Accompany the object code with a copy of the GNU GPL and this license document.

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d) Do one of the following:

0) Convey the Minimal Corresponding Source under the terms of this License, and the Corresponding Application Code in a form suitable for, and under terms that permit, the user to recombine or relink the Application with a modified version of the Linked Version to produce a modified Combined Work, in the manner specified by section 6 of the GNU GPL for conveying Corresponding Source.

1) Use a suitable shared library mechanism for linking with the Library. A suitable mechanism is one that (a) uses at run time a copy of the Library already present on the user's computer system, and (b) will operate properly with a modified version of the Library that is interface-compatible with the Linked Version.

e) Provide Installation Information, but only if you would otherwise be required to provide such information under section 6 of the GNU GPL, and only to the extent that such information is necessary to install and execute a modified version of the Combined Work produced by recombining or relinking the Application with a modified version of the Linked Version. (If you use option 4d0, the Installation Information must accompany the Minimal Corresponding Source and Corresponding Application Code. If you use option 4d1, you must provide the Installation Information in the manner specified by section 6 of the GNU GPL for conveying Corresponding Source.)

5. Combined Libraries.

You may place library facilities that are a work based on the Library side by side in a single library together with other library facilities that are not Applications and are not covered by this License, and convey such a combined library under terms of your choice, if you do both of the following:

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If the Library as you received it specifies that a proxy can decide whether future versions of the GNU Lesser General Public License shall apply, that proxy's public statement of acceptance of any version is permanent authorization for you to choose that version for the Library.

### 1.12.9 Zlib License

See http://www.zlib.net/zlib_license.html

/* zlib.h -- interface of the 'zlib' general purpose compression library version 1.2.8, April 28th, 2013


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Jean-loup Gailly Mark Adler

jloup@gzip.org madler@alumni.caltech.edu

### 1.12.10 ZeroMQ Free Software Licenses

See http://zeromq.org/area:licensing

See ***GNU Lesser General Public License*** (page 1-27) for the GNU Lesser General Public License V3 referred to below.

The libzmq library is licensed under the GNU Lesser General Public License V3 plus a static link exception.

You get the full source code. You can examine the code, modify it, and share your modified code under the terms of the LGPL.

Static linking exception. The copyright holders give you permission to link this library with independent modules to produce an executable, regardless of the license terms of these independent modules, and to copy and distribute the resulting executable under terms of your choice, provided that you also meet, for each linked independent module, the terms and conditions of the license of that module. An independent module is a module which is not derived from or based on this library. If you modify this library, you must extend this exception to your version of the library.

**ZeroMQ for Commercial Applications**

ZeroMQ is safe for use in close-source applications. The LGPL share-alike terms do not apply to applications built on top of ZeroMQ.

You do not need a commercial license. The LGPL applies to ZeroMQ's own source code, not your applications. Many commercial applications use ZeroMQ.

## 1.13 Intellectual property

Currently, one, or more, U.S. and foreign patents are pending.

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# 2 Introduction

Thank you for purchasing a system from Spirent, world leaders in Satellite Navigation System simulation. The combination of Spirent signal generator hardware and software provides a powerful and flexible tool for testing Galileo, GLONASS and GPS. With this power, there is a degree of complexity. This user manual lets you exploit the full capability of your system and provides all the information you need to use the SimGEN software.

## 2.1 Satellite navigation systems - a description

***Note**: GLONASS uses an FDMA structure with channel numbers, K, ranging from -7 to +6.*
*GLONASS L1 frequency = 1602 +/- (K x 0.5625) MHz;*
*GLONASS L2 frequency = 1246 +/- (K x 0.4375) MHz*

This section gives overviews of the major Global Navigation Satellite Systems (GNSS) supported by Spirent simulators. For reference, this table gives frequencies in use by the Galileo, GLONASS and GPS satellite systems.

| Satellite system | Centre Frequency, MHz |
|---|---|
| **Galileo** | |
| E1 | 1575.42 |
| E5 (made up of E5a and E5b) | 1191.795 |
| E5a | 1176.45 |
| E5b | 1207.14 |
| E6 | 1278.75 |
| **GLONASS** | |
| L1, Channel 0 | 1602.0 |
| L2, Channel 0 | 1246.0 |
| **GPS** | |
| L1 | 1575.42 |
| L2 | 1227.6 |
| L5 | 1176.45 |

### 2.1.1 Galileo

Galileo comprises a constellation of Earth-orbiting satellites capable of supporting precise positioning and navigation for both worldwide terrestrial and Earth-orbiting vehicles.

The Galileo system provides a number of navigation and positioning services, including a free-to-use Open Service (OS), a charge-free Safety of Life service (SoL) and Search and Rescue (SAR) service, and a chargeable Commercial Service (CS) incorporating encryption. A Public Regulated Service (PRS) for approved Government-level users incorporates classified encryption and unauthorised access denial.

For reference, the following table details the Galileo signal structure:

| Service | Frequency | | |
|---|---|---|---|
| | E1<br>(1 575.42 MHz) | E5<br>(1 191.795 MHz) | E6<br>(1 278.75 MHz) |
| **F/NAV**<br>Open Service (OS) | | E5a-I<br>E5a-Q | |

The following services are only available to authorised users


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| Service | Frequency | | |
|---|---|---|---|
| **I/NAV**<br>Safety of Life (SoL) | E1-B<br>E1-C | E5b-I<br>E5b-Q | |
| **C/NAV**<br>Commercial Service (CS) | | | E6-B<br>E6-C |
| **G/NAV**<br>Public Regulated Service (PRS) | E1-A | | E6-A |

*Galileo Open Service constellation editor* (page 12-1) details creating a Galileo Open Service constellation.

SimGEN, in conjunction with a suitable signal generator, supports Galileo Open Service (OS). With a suitable dongle, authorised users certain signal generators support Galileo's Commercial Service and Safety of Life, and Public Regulated Service. Contact Spirent for more details.

### 2.1.2 GLONASS

The GLObal Navigation Satellite System (GLONASS) is a satellite-based radio positioning, navigation and time-transfer system similar to GPS, but differing in many respects. Two levels of service are available, Standard Accuracy System and the High Accuracy System. The system consists of three segments: Space, Control and User.

**Space Segment** - consists of 24 satellites in three orbital planes, with eight satellites in each plane. C/A- and P-codes modulate the L1 signal. These codes are pseudo-random codes with independent navigation data super-imposed. Normally, only P-code modulates the L2 signal with navigation data super-imposed. The pseudo-random number associated with spreading the signal is the same for all satellites.

Satellites transmit on a 'comb' of frequencies (FDMA), the distinction between the satellites being made by assigning different channel numbers to which the receiver may tune. The navigation data includes satellite clock, ephemeris (precise satellite position) and almanac (coarse satellite position) information.

GLONASS P-code is not available for general use.

**Control Segment** - consists of a number of Earth-based monitor stations that track the GLONASS satellites and provide information to the Master Control Station. The Master Control Station determines the satellite orbits and uploads navigation data to each satellite at regular intervals.

**User Segment** - utilises the signals transmitted from each satellite, together with precise measurement of the signal transmission delays and Doppler shifts, to determine the receiver's position and velocity. The receiver also synchronises its internal clock to GLONASS time.

*GLONASS constellation editor* (page 11-1) details creating a GLONASS constellation.

SimGEN, in conjunction with a suitable signal generator, supports GLONASS L1 and L2.

### 2.1.3 GPS

The Global Positioning System (GPS) is a satellite-based radio positioning, navigation and time-transfer system. Two levels of service are available, the Standard Positioning Service (SPS) and the Precise Positioning Service (PPS). The system consists of three segments:

**Space Segment** - consists of 24, or more, satellites in six orbital planes with at least four satellites in each plane. Each satellite uses a unique pseudo-random code to transmit, on three frequencies (L1, L2 and L5), a spread-spectrum signal modulated with navigation data that includes satellite clock, ephemeris (precise satellite position) and almanac (coarse satellite position) information.

**Control Segment -** consists of a number of Earth-based monitor stations that track the GPS satellites and provide information to a Master Control Station. The Master Control Station determines the satellite orbits and uploads navigation data to each satellite at regular intervals.

**User Segment -** utilises the signals transmitted from each satellite, together with precise measurement of the signal transmission delays and Doppler shifts, to determine the receiver's position and velocity. The receiver also synchronises its internal clock to GPS time. The receiver uses correlation techniques (CDMA) on the transmitted pseudo-random code to discriminate between GPS satellites. Authorised users can encrypt the P-code, which is then termed Y-code.

In high-dynamic environments, external sensors such as altimeters or inertial navigation equipment can aid GPS receivers, with the combined equipment being capable of overcoming shortcomings of either system.

*GPS constellation editor* (page 10-1) details creating a GPS constellation.

SimGEN, in conjunction with a suitable signal generator, supports GPS L1, L2 and L5.



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### 2.1.4 SBAS

Satellite Based Augmentation Systems (SBAS) augment primary navigation systems such as GPS and GLONASS and provide increased accuracy, integrity and availability. The transport mechanism relies on a radio signal transmitted by one or more Geostationary satellites that has a similar form to the GPS signal. WAAS, EGNOS, and MSAS are examples of such systems.

A network of ground-monitoring stations evaluates the performance of the relevant navigation constellations, obtaining accuracy improvement by calculating pseudorange correction information for the SBAS satellites to broadcast in a navigation message. The SBAS system rapidly achieves improved integrity by including 'Don't use' type information whenever it detects a problem with a navigation satellite.

Additional ranging capability for the Geostationary SBAS satellites improves SBAS availability.

***SBAS constellation editor*** (page 14-1) details creating an SBAS constellation..

## 2.2 Spirent satellite navigation simulators

A Spirent simulator provides comprehensive facilities for development and production testing of Satellite Navigation equipment and for integration studies. The simulator reproduces the environment of a navigation receiver installed on a dynamic platform. RF signals can simulate the effects of high-dynamic host vehicle motion, navigation satellite motion and Ionospheric and Tropospheric effect

***Signal generator*** (page 2-3) and ***SimGEN*** (page 2-6) describe the two elements of a simulator, the signal generator and SimGEN.

### 2.2.1 Signal generator

***Note****:*

***1)*** *SimGEN supports GSS7000 signal generators from version 6-00 onwards*

***2)*** *SimGEN supports GSS9000-series signal generators from version 5-02 onwards*

***3)*** *SimGEN supports Spirent's GSS6700 signal generators from version 2-83 onwards*

The signal generator provides signals that stimulate the receiver or sensor under test - you can consider the signal generator as a "pseudorange to RF" converter. Each signal generator channel represents a satellite signal at a single carrier frequency. Channels may simulate a direct satellite signal or a reflected (multipath) signal.

Signal generators may be single- or dual-output depending on type.

Spirent signal generators that use SimGEN:

| Current signal generator models and description |
|---|
| GSS7000 - capability depends on installed licence files |
| GSS9000-series - capability depends on installed licence files |
| GSS8000-series Galileo (L1/E5/E6), GLONASS (L1/L2) and GPS (L1, L2 and L5) capable |
| GSS7790 Multiple-output L1, L2 C/A Code, P(Y) Code, M-Noise / AES-M-Code capable |
| GSS7765 Interference Simulator |
| GSS6700 Multiple channel, multiple constellation |
| GSS4150 LAAS VHF Data Broadcast Generator |

| Superseded signal generator models and description |
|---|
| GSS6560 12-channel L1 C/A code GPS + SBAS |
| GSS5060 12-channel L1 C/A code GPS + SBAS |
| GSS4750 Multi-channel GPS L5 |
| STR4760GPS + SBAS |
| GSS4765 Interference Simulator |


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| Superseded signal generator models and description |
|---|
| STR4780 Multi-channel GLONASS L1, C/A |
| STR4790 Multi-output GPS L1/L2 |
| GSS7700 GPS + SBAS |
| GSS7800 single output Galileo capable |
| GSS7900 single output GPS (L1) and Galileo (E1 and E5) capable |

GSS9000-series and GSS7000 signal generators support Galileo Open Service.

For GSS8000-series signal generators, to use Galileo Open Service you must use both SimGEN (version 2-83 SR02 onwards) and a Spirent signal generator that supports Galileo. You may also need to upgrade the FPGA release and/or firmware version of each signal generator card installed in your signal generator. To find the firmware version and FPGA image of your signal generator cards and then determine if your signal generator needs upgrading, Spirent recommends you follow this procedure:

- → Read **Menus-*Hardware Configuration*** (page 5-18), then display your signal generator configuration
- → Select your signal generator
- → Click **Output details…**
- → Contact Spirent Global Services and provide the relevant details from the configuration window.
- → Spirent Global Services will then determine if your signal generator needs upgrading and provide details on the upgrade procedure.

#### 2.2.1.1 Available RF signal range

***Notes for GSS8000-series, and earlier, signal generators only**:*

***1)** An extended dynamic range is available from SimGEN version 2-70 on*

***2)** The power levels assume processor firmware version 4-33 or higher. Before this firmware version, the availability of power levels above +20 dB and below -39.9 dB could differ between signal generators*

***Notes for all signal generators**:*

***3)** Power levels below -39.9 dB (-169.9 dBm) are effectively off*

***4)** SimGEN displays levels down to -49 dB*

The available RF dynamic range from Spirent signal generators depends on the type of signal you are simulating and your signal generator. In certain instances, SimGEN may indicate signal-levels outside of the ranges in the following tables, which, always take precedence when describing actual simulated RF power.

**Current Spirent signal generators**

| Signal type | Signal generator | Available range, dB (referred to -130 dBm unless otherwise stated) |
|---|---|---|
| LoS | GSS9000-series | +20 to -49 |
| Multipath GR + FO | GSS9000-series | +20 to -49 |
| Mulipath LMM | GSS9000-series | +20 to -49 |
| Antenna Level Patterns | GSS9000-series | +20 to -49.9 for LoS<br>+20 to -49.9 for all multipath |
| LoS | GSS8000-series | +20 to -49 |
| Multipath GR+ FO | GSS8000-series | +20 to -49 |


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| Signal type | Signal generator | Available range, dB (referred to -130 dBm unless otherwise stated) |
|---|---|---|
| Multipath LMM | GSS8000-series | +20 to -49 |
| Antenna Level Pattern | GSS8000-series | +20 to -49.9 for LoS<br>+20 to -49.9 for all multipath |
| LoS | GSS7000 | +15 to -49 |
| Multipath GR+ FO | GSS7000 | +15 to -49 |
| Multipath LMM | GSS7000 | +15 to -49 |
| Antenna Level Pattern | GSS7000 | +15 to -49 for LoS and Multipath |
| LoS | GSS6700 | +15 to -49 See Note 1) |
| Multipath GR+ FO | GSS6700 | +15 to -49 |
| Multipath LMM | GSS6700 | +15 to -49 |
| Antenna Level Pattern | GSS6700 | +15 to -49 for LoS and Multipath |
| LoS | GSS4150 | +20 to -20 (with respect to -70 dBm) |
| Antenna Level Pattern | GSS4150 | +20 to -20 (with respect to -70 dBm) |

GR: Ground reflection, FO: Fixed Offset, LMM: Land Mobile Multipath, LoS: Line-of-Sight

**Superseded Spirent signal generators**

| Signal type | Signal generator | Available range, dB (referred to -130 dBm unless otherwise stated) |
|---|---|---|
| LoS | GSS6560 | +15 to -49 See Note 1) |
| Multipath GR+ FO | GSS6560 | +15 to -49 |
| Multipath LMM | GSS6560 | +15 to -49 |
| Antenna Level Pattern | GSS6560 | +15 to -49 for LoS and Multipath |
| LoS | GSS5060 | +15 to -49 See Note 1) |
| Multipath GR+ FO | GSS5060 | +15 to -49 |
| Multipath LMM | GSS5060 | +15 to -49 |
| Antenna Level Pattern | GSS5060 | +15 to -49 for LoS and Multipath |
| LoS | STR4760/80/90 and GSS4750 | +20 to -39 See Note 1) and 2) |
| Multipath GR+ FO | STR4760/80/90 and GSS4750 | +20 to -39 See Note 2) and 3) |
| Multipath LMM | STR4760/80/90 and GSS4750 | +20 to -39 See Note 2) and 4) |
| Antenna Level Pattern | STR4760/80/90 and GSS4750 | +20 to -39.9 for LoS<br>+20 to -39.9 for all multipath<br>See Note 2) |
| LoS | GSS7700 | +20 to -49 See Note 1) |


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| Signal type | Signal generator | Available range, dB (referred to -130 dBm unless otherwise stated) |
|---|---|---|
| Multipath GR+ FO | GSS7700 | +20 to -49 |
| Multipath LMM | GSS7700 | +20 to -49 |
| Antenna Level Pattern | GSS7700 | +20 to -49.9 for LoS<br>+20 to -49.9 for all multipath |

GR: Ground reflection, FO: Fixed Offset, LMM: Land Mobile Multipath

### 2.2.2 SimGEN

SimGEN is a suite of software used in the Spirent range of Satellite Navigation Simulator products.

SimGEN runs on the SimGEN Controller (a Windows PC) and lets you specify and develop scenarios to run simulations. A scenario has a unique name and uses a set of source, files, each of which has its own specific editor. A database maintains the relationship between scenarios and source files. During a simulation, SimGEN runs models that act on the source file information and calculate the pseudorange (apparent distance) between the simulated visible satellites and the simulated vehicle carrying the GNSS antenna and receiver. SimGEN provides information such as navigation data, signal arrival angle and power level to the signal generator.

The signal generator can modulate signals with standard and non-standard combinations of codes and navigation data. SimGEN lets you manipulate the simulated satellite orbits and the navigation data describing them.

You can access simulated parameters, allowing graphical or tabular display or comparison with data the receiver computes. You can repeat scenarios with high-accuracy and simulate a wide range of normal and abnormal situations.

SimGEN supports Spirent's next generation Location Test Systems, ULTS (Universal Location Test System) and PLTS (Position Location Test System). Spirent supplies a licence file to enable ULTS and PLTS features in SimGEN.

From SimGEN version 2-83 SR02 onwards, all SimGEN users can access Galileo's Open Service. Only authorised Galileo users can access Galileo's Safety of Life (SoL), Commercial Service (CS) and Public Regulated Service (PRS). Contact Spirent for further details.

### 2.2.3 SimREPLAY and SimREPLAYplus

***Note**:*

***1)** PosApp version 6-00 onwards does not support SimREPLAY. The information in this section relating to SimREPLAY is for legacy support.*

***2)** Not all SimGEN parameters are editable in SimREPLAY or SimREPLAYplus. Before using SimGEN to create a "replay" scenario, and if you use SimGEN to create "replay" scenarios, Spirent recommends:*

***a)** You use SimGEN to set-up the relevant constellations using only the parameters you want.*

***b)** You deselect or otherwise disable parameters you do not want to include in your scenario.*

This section outlines Spirent's SimREPLAY and SimREPLAYplus software and the GSS7000 and GSS6700 signal generator. You can use SimGEN to create "replay" scenarios for use with SimREPLAY or SimREPLAYplus controlling the GSS6700 and for SimREPLAYplus controlling the GSS7000 signal generator.

As well as controlling GSS7000 and GSS6700 signal generators using SimGEN, you can use SimGEN to create "replay" scenarios for use with Spirent's SimREPLAY and SimREPLAYplus software and the GSS7000 and GSS6700.

"Replay" scenarios use the extension **.scn_replay*. Important points on using SimREPLAY and SimREPLAYplus software are:

- → SimREPLAY lets you edit certain parameters in existing scenarios and save the resulting scenario.
- → SimREPLAY cannot create NEW scenarios (for example, a scenario using a different start-time or orbital parameters). To do this, you need SimREPLAYplus or SimGEN.
- → As well as running **.scn_replay* scenarios, SimREPLAYplus lets you create **.scn_replay* scenarios using a sub-set of the editable parameters available in SimGEN.
- → You can only use SimGEN to create a "replay" scenario when you connect an appropriately licenced GSS6700 to your SimGEN Controller; or use a SimGEN licence on your GSS7000.

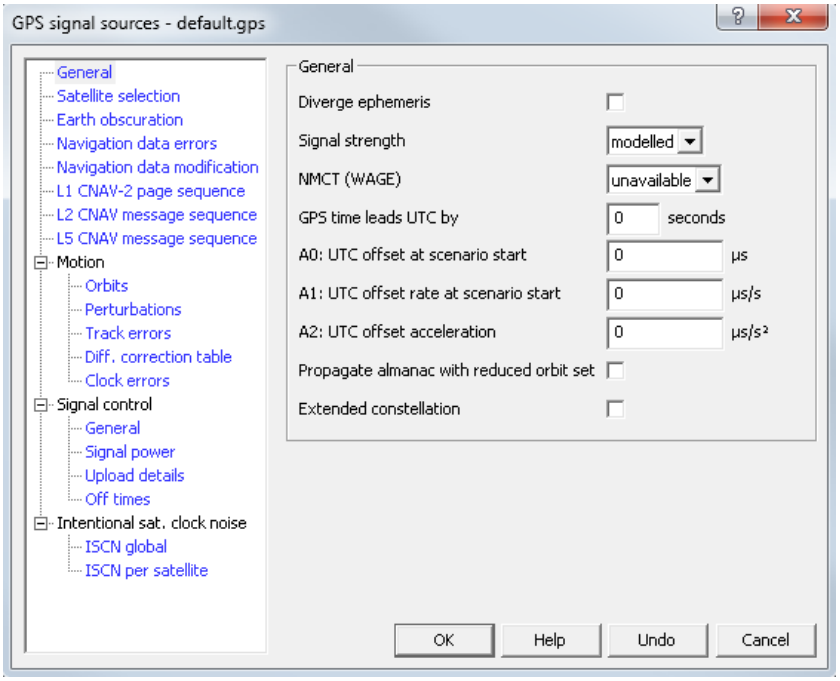

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→ The GSS7000 signal generator running Spirent's SimTEST software will replay all SimREPLAY and SimREPLAYplus scenarios created up to PosApp version 6-00.

Reference mm) details using the GSS6700 signal generator with SimREPLAY and SimREPLAYplus software up to PosApp version 5-07SR02. Spirent recommends you read this document especially the limitations on editable parameters, before using SimGEN to create **.scn_replay* scenarios for this signal generator.

Reference yyy) details using the GSS7000 and GSS6700 signal generators with SimREPLAYplus software from PosApp version 6-00 onwards. Spirent recommends you read this document especially the limitations on editable parameters, before using SimGEN to create **.scn_replay* scenarios for these signal generators.

SimGEN's **Scenario contents** window uses blue text to identify editable parameters:




Black text in the **Scenario contents** window identifies read-only parameters . The parameter window includes a "read-only" watermark as a background.

SimGEN users will normally see all parameters as editable (blue text). Only SimREPLAY and SimREPLAYplus users will see non-editable parameters (black text).

If you use SimGEN to create "replay" scenarios, SimGEN will use (and, if set, show in the SimREPLAY/SimREPLAYplus **Scenario contents** window) every parameter the GSS7000 / GSS6700 signal generator supports (for example Land Mobile Multipath). SimREPLAY / SimREPLAYplus users can only edit the scenario parameters shown in blue text; all other parameters are read-only.

Consequently, if you use SimGEN to create a scenario and set a non-editable "replay" parameter, you can only edit that parameter by re-creating the scenario using SimGEN and using SimGEN to save the new "replay" scenario.

#### 2.2.3.1 Using SimGEN to create a "replay" scenario

***Notes for PosApp version 6-00 onwards***

***1)*** *PosApp version 6-00 onwards supports the GSS7000 signal generator and only supports generation of SimREPLAYplus scenarios.*

***2)*** *The GSS7000 signal generator supports SimREPLAY and SimREPLAYplus scenarios generated using PosApp 5.07 and earlier*

***Notes for SimREPLAY/SimREPLAYpus users up to PosApp 5-07****:*

***1)*** *You can only create a "replay" scenario using SimGEN v 2-83 onwards.*

***2)*** *To save a SimGEN scenario file (*.scn extension) so it is compatible with SimREPLAY and SimREPLAYplus (*.scn_replay extension), first connect your SimGEN-compatible signal generator to the SimGEN Controller. SimGEN then checks the USB (or IEEE-488) ports for an appropriately licenced signal generator. If SimGEN cannot detect a suitable signal generator, SimGEN displays a warning message if it cannot detect a suitable signal generator.*

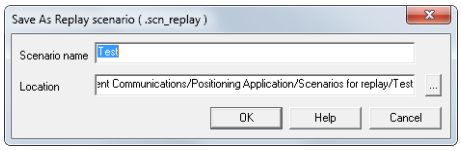
Spirent recommends you read reference mm) before using SimGEN to create a “replay” scenario. Be aware that SimGEN will use (and, if set, show in the SimREPLAY **Scenario contents** window) every parameter your signal generator supports.

For all versions of SimREPLAYplus (or SimREPLAY) you can only edit a scenario parameter shown in blue text in the **Scenario contents** window; all parameters in black text are read-only.

### 2.2.3.2 Example creating a replay scenario using PosApp prior to version 6-00

The following example creates a “replay” scenario, using a GSS6700 signal generator:

- Connect your GSS6700 signal generator to the SimGEN Controller
- Apply ac power to the GSS6700 and start the signal generator
- Start SimGEN
- Notice that to create a replay scenario, SimGEN must enter “dummy run” mode (**Options-General Options-No hardware (“dummy run”**). SimGEN automatically enters this mode if it is not in use
- The SimGEN title bar text changes to ‘**SimGEN (SimREPLAY scenario generation) - scenario_name.scn**’.
- The **File** menu shows a tick next to SimREPLAY mode
- Select **File-Save As Replay scenario (.scn_replay)…**
- SimGEN displays the **Save As Replay** scenario dialog:



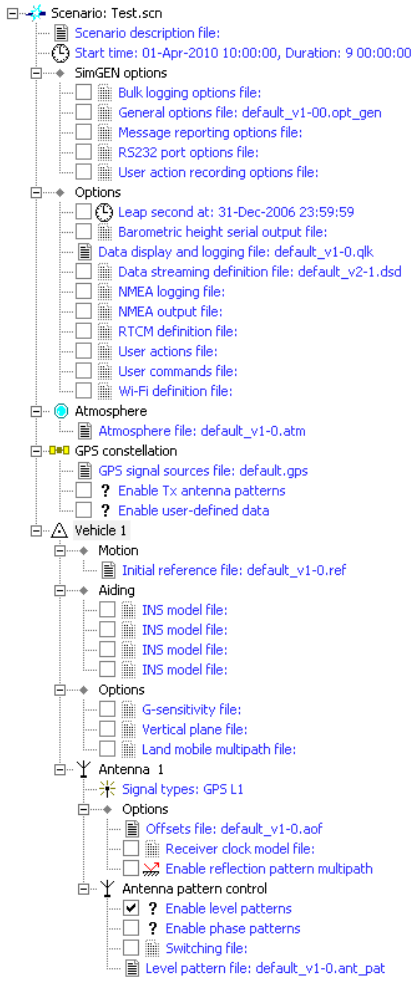

Notice that SimGEN saves “replay” scenarios to the default folder
*C:\Program Files\Spirent Communications\Positioning Application\Scenarios for replay*

Click on the Browse button (**…**) to select an alternative folder. Then:

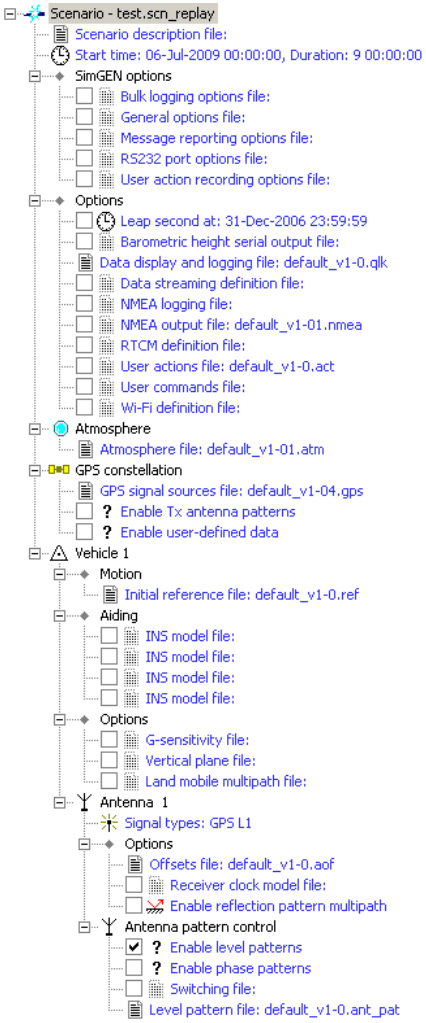
- Type a name for your “replay” scenario and click **OK**. The SimGEN title bar changes to ‘**SimGEN (SimREPLAY scenario generation) - ‘scenario_name.scn_replay**’.
- Click **File-SimREPLAY Mode** to return to the standard SimGEN mode. The title bar text returns to ‘**SimGEN - scenario_name.scn**’
- The following figure is a fully expanded **Scenario contents** window for the scenario *Test.scn.* It includes **Vehicle-Options-Land mobile multipath file** - you can edit this file type in SimGEN, but you cannot edit this file type in SimREPLAY or SimREPLAYplus.



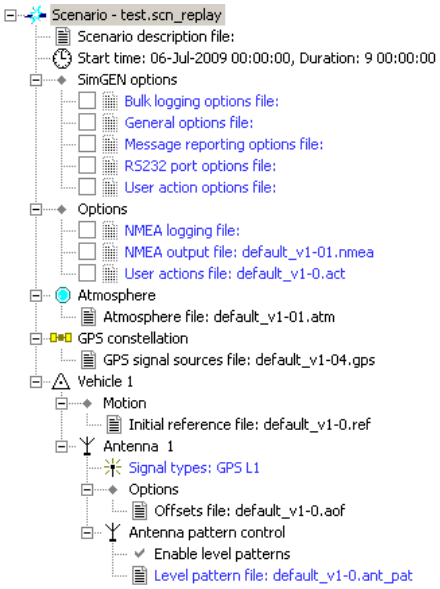
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The following figure shows the scenario *Test.scn* after saving in SimGEN as a “replay” scenario - the scenario name is now *Test.scn_replay* and all parameters remain editable (blue text).

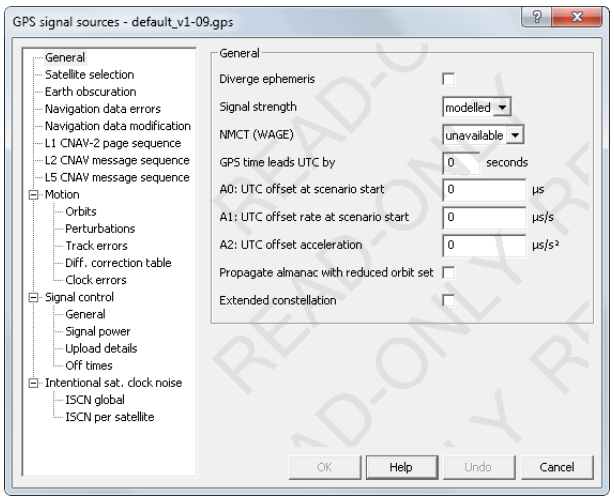



Now the same “replay” scenario in SimREPLAY:

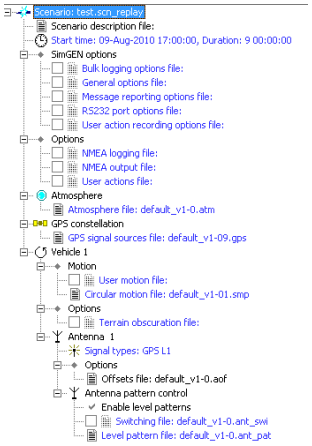



Parameters in black text are read-only. For example, the parameter **GPS signal sources file** is in black text and is read-only, as the watermark shows:

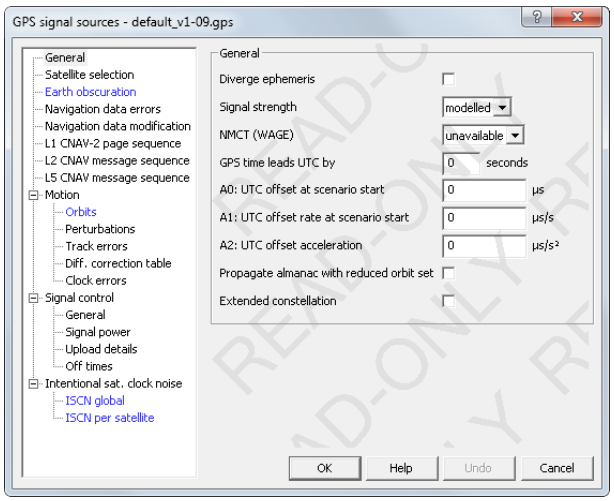

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The following figure is the scenario *test.scn_replay* as it appears in SimREPLAYplus. Blue text indicates parameters you can edit in SimREPLAYplus and black text indicates parameters you cannot edit. Notice the parameter **GPS signal sources file** is in blue text, indicating it is editable.



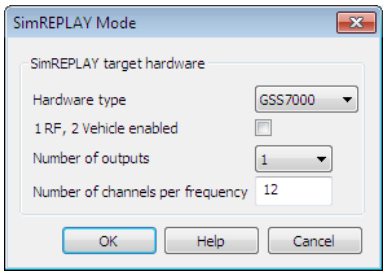

This figure shows some parameters in black text (read-only) and four are in blue text (editable).



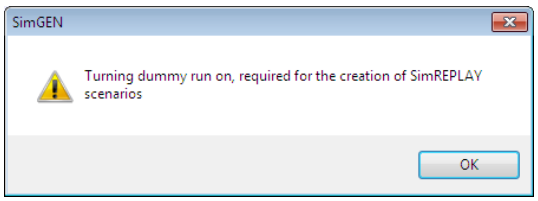
### 2.2.3.3 Example creating a replay scenario using PosApp version 6-00 onwards

The following example creates a “replay” scenario, using a GSS7000 signal generator:

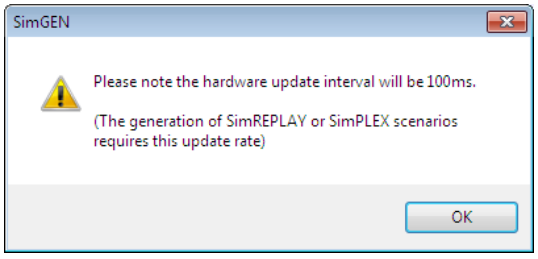
- Apply ac power to the GSS7000 and start the signal generator
- Start SimGEN
- Set-up the “replay” scenario you want to generate using the appropriate parameters for each constellation
- Ensure you set only those SimGEN parameters you want to use in the “replay” scenario
- In SimGEN, click on **File-Enter SimREPLAY Mode**
- Select your signal generator details in the **SimREPLAY Mode dialog**:



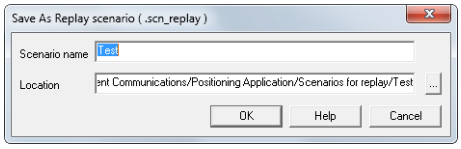

- Notice that to create a replay scenario, SimGEN must enter “dummy run” mode (**Options-General Options-No hardware (“dummy run”**). SimGEN automatically enters this mode if it is not in use:




- The Hardware Update Interval is also set to 100 milliseconds for SimREPLAYplus:




- The SimGEN title bar text changes to ‘**SimGEN (SimREPLAY scenario generation) - scenario_name.scn**’.
- The **File** menu shows a tick next to SimREPLAY mode
- Select **File-Save As Replay scenario (.scn_replay)…**
- SimGEN displays the **Save As Replay** scenario dialog:




Notice that SimGEN saves “replay” scenarios to the default folder *D:\posapp\scenarios*

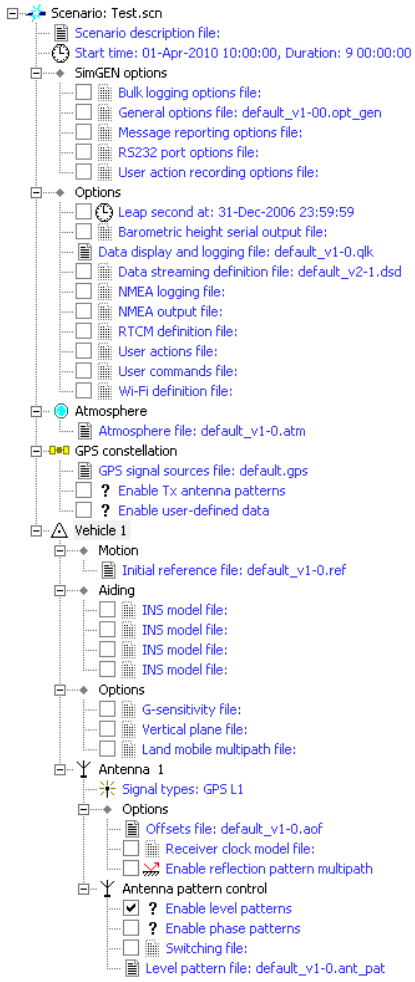
Spirent recommends you always use this default location. Then:


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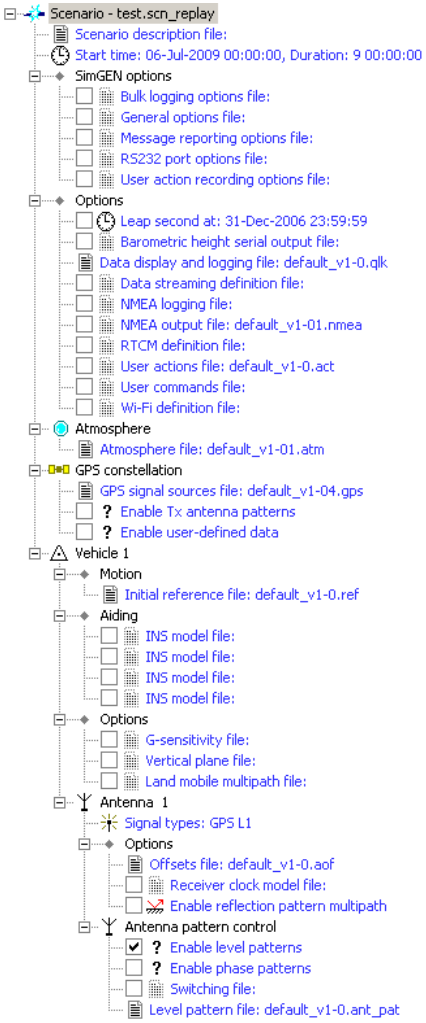
→ Type a name for your “replay” scenario and click **OK**. The SimGEN title bar changes to ‘**SimGEN (SimREPLAY scenario generation) - ‘scenario_name.scn_replay**’.

→ Click **File-SimREPLAY Mode** to return to the standard SimGEN mode. The title bar text returns to ‘**SimGEN - scenario_name.scn**’

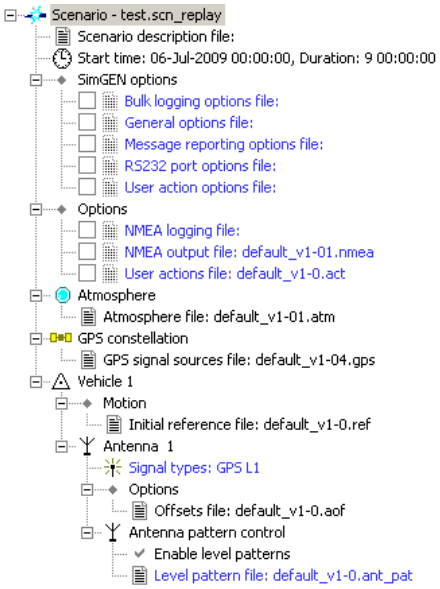
→ The following figure is a fully expanded **Scenario contents** window for the GSS7000 using the scenario *7000_Test.scn.* It includes **Vehicle-Motion-Rectangualr racetrack file** - you can edit this file type in SimGEN, but you cannot edit this file type in SimREPLAYplus.




The following figure shows the scenario *Test.scn* after saving in SimGEN as a “replay” scenario - the scenario name is now *Test.scn_replay* and all parameters remain editable (blue text).

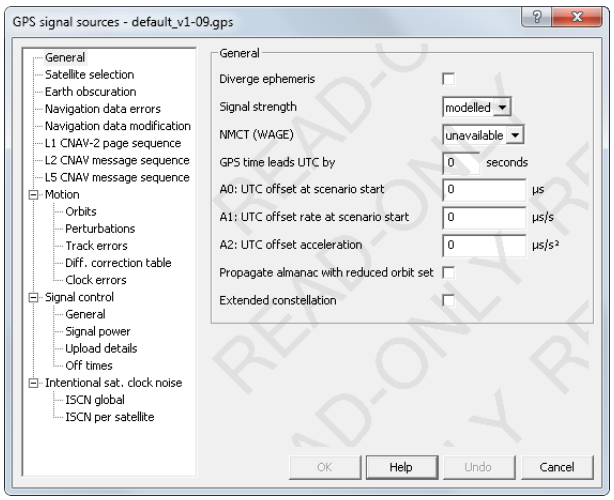



Now the same “replay” scenario in SimREPLAY:

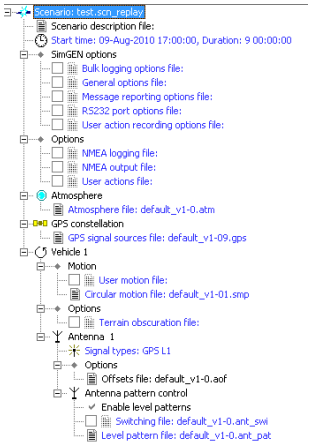



Parameters in black text are read-only. For example, the parameter **GPS signal sources file** is in black text and is read-only, as the watermark shows:

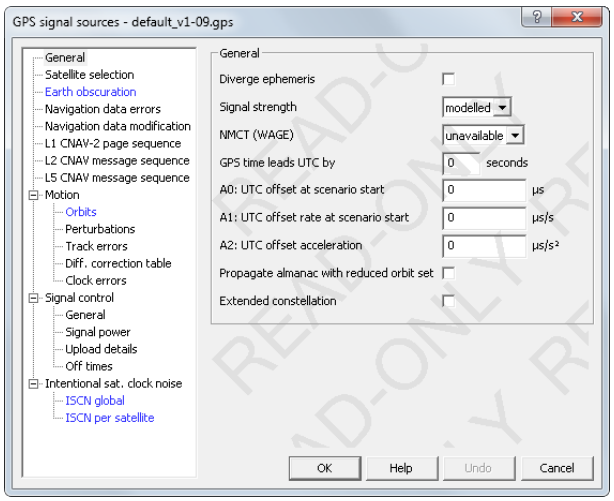

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The following figure is the scenario *test.scn_replay* as it appears in SimREPLAYplus. Blue text indicates parameters you can edit in SimREPLAYplus and black text indicates parameters you cannot edit. Notice the parameter **GPS signal sources file** is in blue text, indicating it is editable.




This figure shows some parameters in black text (read-only) and four are in blue text (editable).



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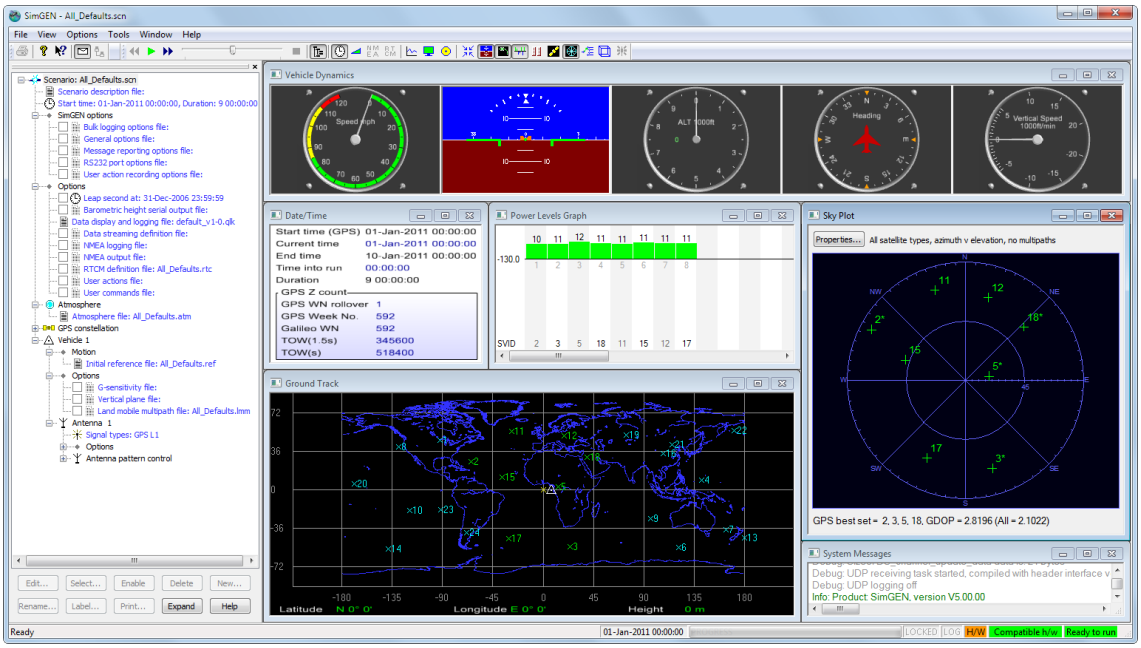


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# 3 Main display windows

***Note**: SimGEN's main display windows are independent of the constellation or combination of constellations, your scenario uses. This Chapter show screenshots of different constellations to highlight certain features.*

Use the ***View*** (page 5-1) menu to select the windows SimGEN displays.




You can resize each window by first clicking in the window, or selecting it in ***Window*** (page 5-42), to select it, then dragging a corner, or one of its sides, to the size you want.

## 3.1 Vehicles and antennas

Since a GNSS receiver calculates the position of the antenna, rather than the receiver. SimGEN describes the position of the (simulated) antenna using the terms "Vehicle" and "Antenna". You can assign more than one vehicle (Vehicle 1, Vehicle 2 and so on) and, depending on your signal generator, you can assign more than one antenna (Antenna 1, Antenna 2 and so on). This table gives an example of how SimGEN names vehicles and antennas in a scenario using two vehicles, each with two antennas.

| Vehicles and antennas in scenario | SimGEN names |
|---|---|
| First antenna on first vehicle | Vehicle 1, Antenna 1 |
| Second antenna on first vehicle | Vehicle 1, Antenna 2 |
| First antenna on a second vehicle | Vehicle 2, Antenna 1 |
| Second antenna on second vehicle | Vehicle 2, Antenna 2 |

By default, SimGEN uses a single vehicle and a single antenna. You can delete all vehicles and antennas except Vehicle 1, Antenna 1.

You must specify the antenna position relative to the vehicle as, depending on your signal generator, you can simulate one or more antennas mounted at different points on the same vehicle.

During vehicle motion, SimGEN propagates the position of a notional point on the vehicle (generally its "Centre of Gravity" or "Centre of Motion"). The instantaneous position of each antenna on the vehicle will be different from the notional point and could have different velocities, accelerations and jerks. For example, consider an aircraft turning in a circle with antennas mounted on each wingtip.

Specify a "static" vehicle when you want to simulate a receiver that does not move. The static vehicle model co-locates the antenna with the Centre of Motion of the vehicle and does not offset the antenna from the Centre of Motion. Specify a static vehicle when simulating a mobile phone at a fixed location.


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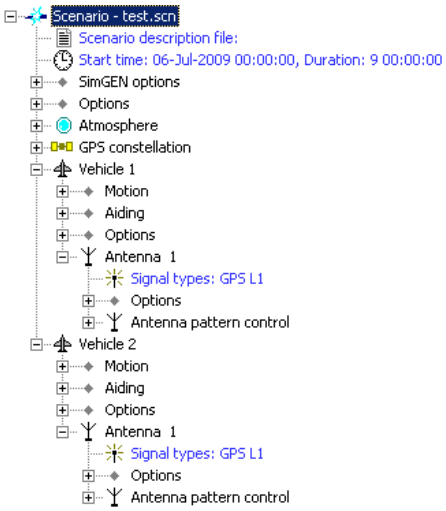
## 3.2 Selecting windows

With a suitable signal generator, you can simulate multiple vehicles and/or multiple antennas. However, most SimGEN windows display data for a single vehicle and antenna.

SimGEN always associates an antenna with a vehicle and you cannot view data for a vehicle or an antenna in isolation. You can use the **Scenario contents** window or the drop-down list to display data for a specific vehicle/antenna combination.

### 3.2.1 Use the Scenario contents window

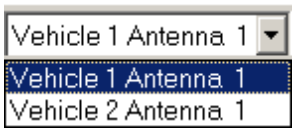
Select the vehicle/antenna combination in the **Scenario contents** window. Any SimGEN window that displays vehicle and / or antenna data (such as ***Vehicle Antenna Position Details*** (page 3-4) or ***Ground Track*** (page 3-12)) will show data for the vehicle/antenna combination you select. For example, this figure shows two vehicles, each with an antenna and **Vehicle 1-Antenna 1** highlighted; consequently, all SimGEN windows will show details for this vehicle and antenna combination.




If you subsequently highlight **Vehicle 2-Antenna 1**, SimGEN continues to show the details for **Vehicle1-Antenna1**. You must choose the windows you want SimGEN to display for **Vehicle2-Antenna1** using the ***View*** menu, before you can see these details. It is only after you have chosen the details for each window that you can switch between the displays by selecting the combination in the **Scenario contents** window or from the drop-down list.

### 3.2.2 Use the drop-down list

When your scenario has more than one vehicle and / or one antenna, the SimGEN toolbar displays the vehicle / antenna drop-down list

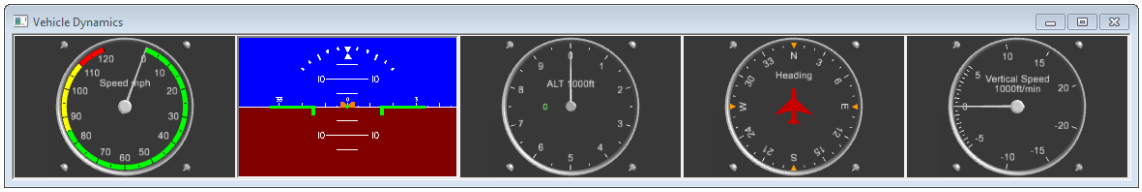



Select the vehicle / antenna from the drop-down list. The vehicle / antenna selection you make here appears in the **Scenario contents** window.

## 3.3 Vehicle Dynamics

These SimGEN windows present information, depending on the vehicle type, using a series of dials familiar to the user of the vehicle:

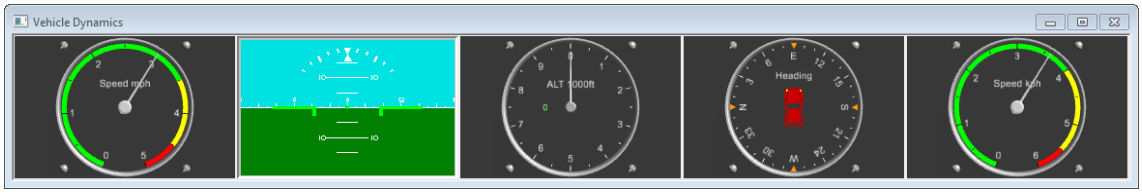
***Static model, Aircraft*** and ***Remote motion***



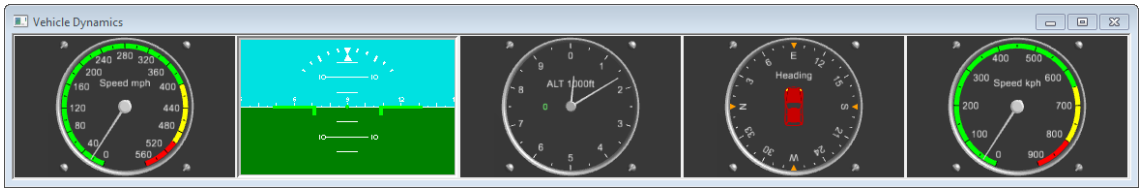


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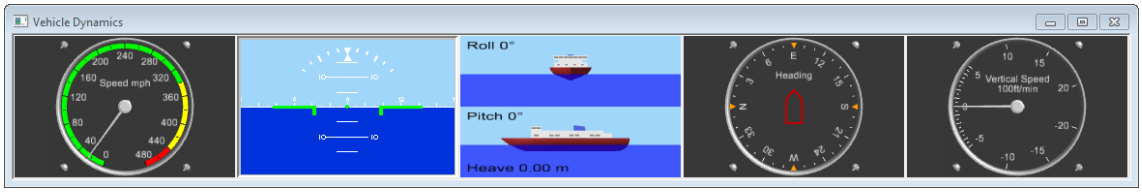
### *Simple motion*



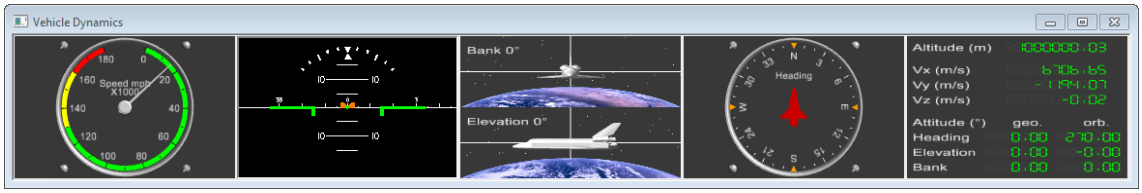

### *Land vehicle*




### *Ship*



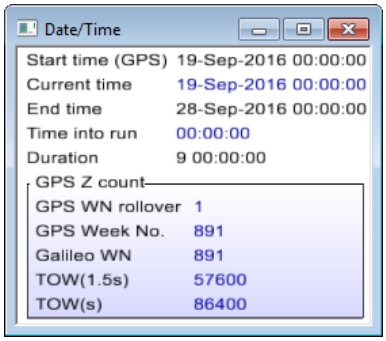

### *Spacecraft*




## 3.4 Date / Time

***Note**: From SimGEN v2-61 on, the start-time of a new scenario is 00:00:00 on the day of creating the scenario. The SimGEN Controller's internal clock determines the day.*

Click the **Date/Time** button  on the toolbar to display the current simulation time, scenario start and end times and duration. You cannot edit the details in this window:




| | |
|---|---|
| **Start time** | The GPS date and time for the scenario start |
| **Current time** | The date and time into the scenario |
| **End time** | The date and time the scenario will finish |

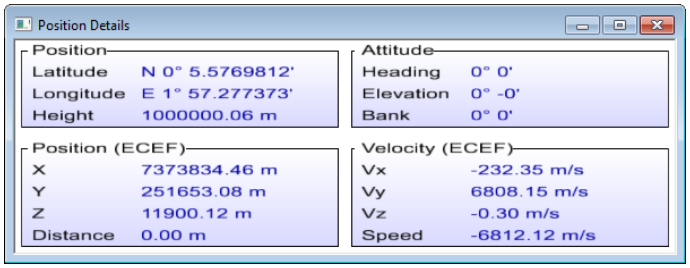

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| | |
|---|---|
| **Time into run** | The elapsed time since starting the scenario |
| **GPS Z count** | The current simulated time in GPS format |
| **GPS WN rollover** | The GPS Week rollover number |
| **GPS Week No** | The GPS week number |
| **Galileo WN** | The Galileo week number |
| **TOW (1.5s)** | Time of Week in 1.5 second units |
| **TOW (S)** | Time of Week in one second units |

## 3.5 Vehicle Antenna Position Details

***Note**: You can mount antennas at different locations on the simulated vehicle, so their positions and velocities will differ.*

Click the **Position details** button  on the toolbar to display the current position in latitude and longitude and ECEF co-ordinates. This window shows velocity and attitude for the vehicle and antenna in the drop-down list. Distance is the same as a vehicle odometer and refers to the total distance travelled (in three dimensions) during the scenario. The window title bar shows the vehicle and antenna details:




If your scenario uses more than one vehicle and antenna, the section ***Selecting windows*** (page 3-2) details how you change the current vehicle / antenna and display the **Vehicle Antenna Position Details** window for a different vehicle / antenna.

DOP indicates the navigational accuracy the receiver can obtain from the currently simulated satellite geometry. DOP of 1 to 2.5 is good, whereas a DOP of 9 is poor. **GPS-*Satellite selection*** (page 10-10) shows setting DOP type for the GPS constellation. This table shows the available DOP types:

| DOP type | Description |
|---|---|
| HDOP | Best horizontal accuracy |
| PDOP | Best positional accuracy |
| VDOP | Best vertical accuracy |
| TDOP | Best time accuracy |
| GDOP | Best geometric arrangement of satellites - best general solution |

## 3.6 Sky Plot

Click the **Sky Plot** button  on the toolbar. **Sky Plot** gives a view “looking down” from a point beyond the satellite orbits and directly above the vehicle position. A satellite that is directly overhead (90° elevation) will be shown at the centre of the **Sky Plot** display. A satellite with zero degrees elevation will be on the circumference of the **Sky Plot** display.

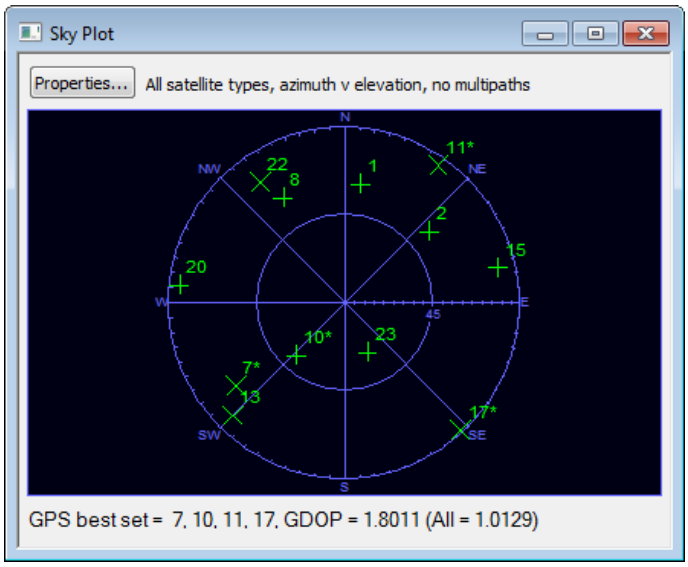
The **Sky Plot** display does not change with changes in vehicle attitude.

**Sky Plot** uses the symbol ‘+’ to show the positions in the sky of the currently simulated satellites, relative to the current vehicle position.

Vehicles at high altitudes may be above certain satellites. **Sky Plot** uses an ‘x’ symbol to identify these satellites. When a vehicle is above a satellite, **Sky Plot** shows that vehicle altitude as the negative of the elevation displayed


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in ***Received Signals*** (page 3-7). **Sky Plot** shows SVID adjacent the '+' (or 'x') symbol, as in the following figure, which shows only GPS satellites.




Double-click anywhere in the **Sky Plot** window to display ***Received Signals*** (page 3-7), which shows satellite and signal data in tabular form.

**Sky Plot** identifies satellites as follows:

| Constellation | Prefix | Example | Constellation | Prefix | Example |
|---|---|---|---|---|---|
| BeiDou | B | B1 | Ground Tx - GPS | T | T2 |
| CAPS | C | C1 | SBAS - EGNOS | E | E2 |
| IRNSS | N | N2 | SBAS - GAGAN | GN | GN1 |
| Galileo | A | A1 | SBAS - MSAS | M | M2 |
| GLONASS | G | G10 | SBAS-SDCM | S | S3 |
| Ground Tx - GLONASS | TG | TG1 | SBAS - WAAS | W | W2 |
| GPS | (none) | 12 | Quasi-Zenith | Q | Q3 |

If your scenario uses more than one vehicle and antenna, ***Selecting windows*** (page 3-2) details changing the current vehicle / antenna and displaying the **Sky Plot** window for a different vehicle / antenna.

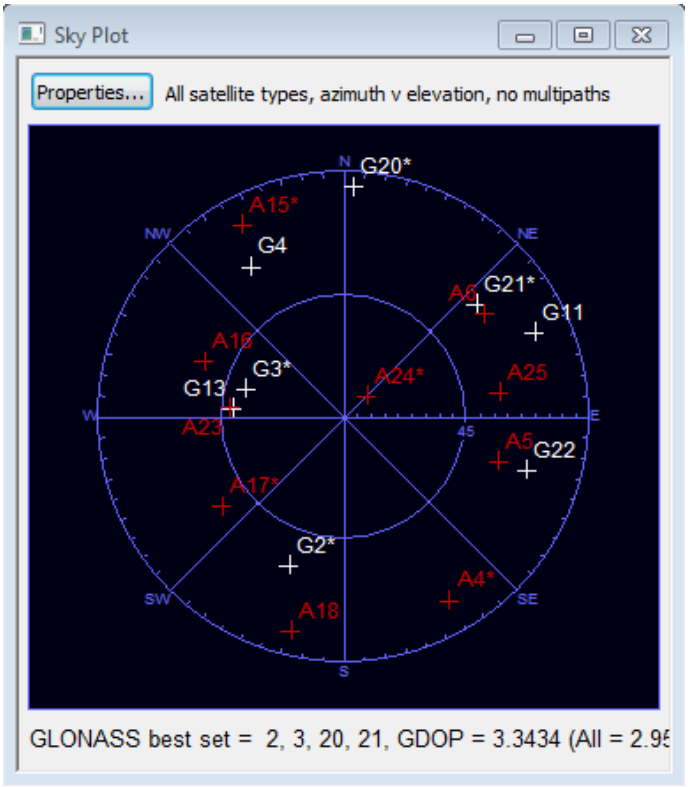
This table details the colours that help distinguish constellations in the **Sky Plot** display:

| Constellation | Colour in Sky Plot | Constellation | Colour in Sky Plot |
|---|---|---|---|
| BeiDou | Amber | GPS | Green |
| CAPS | Grey | Ground Tx - GLONASS | Light red |
| IRNSS | Yellow | LAAS | Red |
| Galileo | Light blue | Quasi-Zenith | Purple |
| GLONASS | White | SBAS | Cyan |

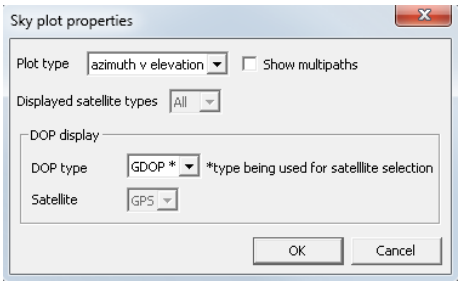

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| Constellation | Colour in Sky Plot | Constellation | Colour in Sky Plot |
|---|---|---|---|
| Ground Tx - GPS | Red | | |

This figure shows GLONASS and Galileo satellites in **Sky Plot**:




SimGEN always indicates with an asterisk (for example, 19*) the four satellites in the “best GDOP set”. You can select other DOP types using **Sky plot-Properties**.




| | |
|---|---|
| **Plot type** | Choose from **azimuth v elevation** (default) or **azimuth v range**. |
| **Show multipaths** | Deselect (default): does not show multipaths<br>Select: show multipaths. The multipath azimuth and elevation values correspond with the Echo values in the ***Received Signals*** (page 3-7) window |
| **Displayed satellite types** | If your scenario uses more than one satellite type (for example GPS and GLONASS), you can choose the satellite type you want to display or use the default **All** |
| **DOP display** | (Dilution Of Precision) lets you select the DOP type shown next to each satellite. This table (page 3-4) details the DOP types. |


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| | |
|---|---|
| **DOP type** | The DOP type you select here only applies to Sky Plot; it does not affect the algorithm used by SimGEN. Similarly, Sky Plot does not use the DOP type SimGEN uses in modelling.<br>Sky Plot shows the calculated DOP values and (where four, or more, satellites are visible) the associated best set of satellites.<br>Choose from: **GDOP** (default), **PDOP**, **HDOP**, **VDOP**, **TDOP** |
| ***Notes**:*<br>***1)** With three satellites visible, SimGEN does not calculate the best set and only calculates **HDOP** and **VDOP***<br>***2)** SimGEN cannot perform DOP calculations with fewer than three satellites visible*<br>***3)** Use **Target DOP value switching file** (page 23-7) to determine the best set closest to the value for the parameter **Target DOP Number** you set in the switching file* | |
| **Satellite** | Enabled only if your scenario uses more than one constellation.<br>Choose the constellation you want to use for the DOP calculation, or choose **All** to use all visible satellites from all constellations in your scenario. The text under the display will show “All constellations:” followed by the DOP type and the calculated DOP. |

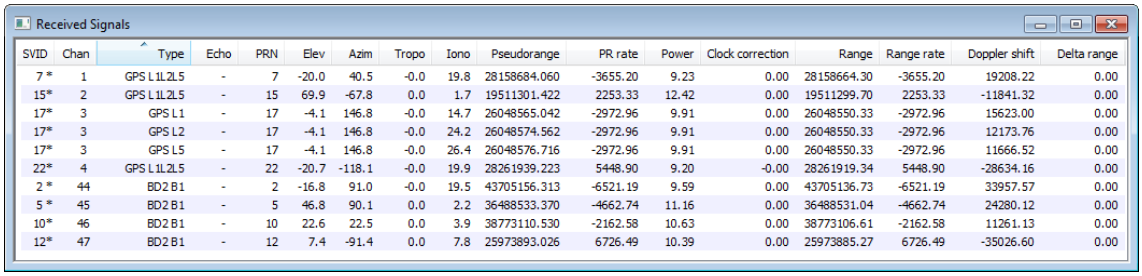
## 3.7 Received Signals

***Notes**:*

***1)** Channel numbering in this window is from one to ‘n’. SimGEN defines channel numbers internally as zero to ‘n-1’ and the **System Messages** window uses SimGEN channel numbering.*

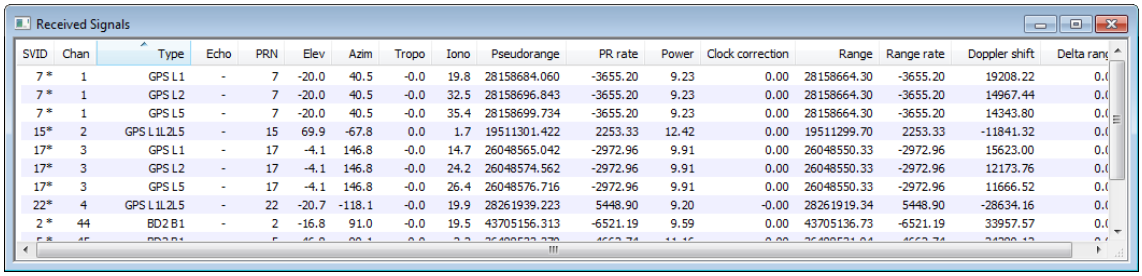
***2)** SimGEN shows power levels for satellites with RF turned off because you cannot select frequencies in this display. However, **Power Levels Graph** is frequency dependent.*

Click the **Received signals** toolbar button  to open the **Received Signals** window. It displays satellite signal data for each channel in tabular form. You can sort the data displayed by each column, the ‘^’ symbol indicates the sort order.




| SVID | Chan | Type | Echo | PRN | Elev | Azim | Tropo | Iono | Pseudorange | PR rate | Power | Clock correction | Range | Range rate | Doppler shift | Delta range |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 7 * | 1 | GPS L1L2L5 | - | 7 | -20.0 | 40.5 | -0.0 | 19.8 | 28158684.060 | -3655.20 | 9.23 | 0.00 | 28158664.30 | -3655.20 | 19208.22 | 0.00 |
| 15* | 2 | GPS L1L2L5 | - | 15 | 69.9 | -67.8 | 0.0 | 1.7 | 19511301.422 | 2253.33 | 12.42 | 0.00 | 19511299.70 | 2253.33 | -11841.32 | 0.00 |
| 17* | 3 | GPS L1 | - | 17 | -4.1 | 146.8 | -0.0 | 14.7 | 26048565.042 | -2972.96 | 9.91 | 0.00 | 26048550.33 | -2972.96 | 15623.00 | 0.00 |
| 17* | 3 | GPS L2 | - | 17 | -4.1 | 146.8 | -0.0 | 24.2 | 26048574.562 | -2972.96 | 9.91 | 0.00 | 26048550.33 | -2972.96 | 12173.76 | 0.00 |
| 17* | 3 | GPS L5 | - | 17 | -4.1 | 146.8 | -0.0 | 26.4 | 26048576.716 | -2972.96 | 9.91 | 0.00 | 26048550.33 | -2972.96 | 11666.52 | 0.00 |
| 22* | 4 | GPS L1L2L5 | - | 22 | -20.7 | -118.1 | -0.0 | 19.9 | 28261939.223 | 5448.90 | 9.20 | -0.00 | 28261919.34 | 5448.90 | -28634.16 | 0.00 |
| 2 * | 44 | BD2 B1 | - | 2 | -16.8 | 91.0 | -0.0 | 19.5 | 43705156.313 | -6521.19 | 9.59 | 0.00 | 43705136.73 | -6521.19 | 33957.57 | 0.00 |
| 5 * | 45 | BD2 B1 | - | 5 | 46.8 | 90.1 | 0.0 | 2.2 | 36488533.370 | -4662.74 | 11.16 | 0.00 | 36488531.04 | -4662.74 | 24280.12 | 0.00 |
| 10* | 46 | BD2 B1 | - | 10 | 22.6 | 22.5 | 0.0 | 3.9 | 38773110.530 | -2162.58 | 10.63 | 0.00 | 38773106.61 | -2162.58 | 11261.13 | 0.00 |
| 12* | 47 | BD2 B1 | - | 12 | 7.4 | -91.4 | 0.0 | 7.8 | 25973893.026 | 6726.49 | 10.39 | 0.00 | 25973885.27 | 6726.49 | -35026.60 | 0.00 |

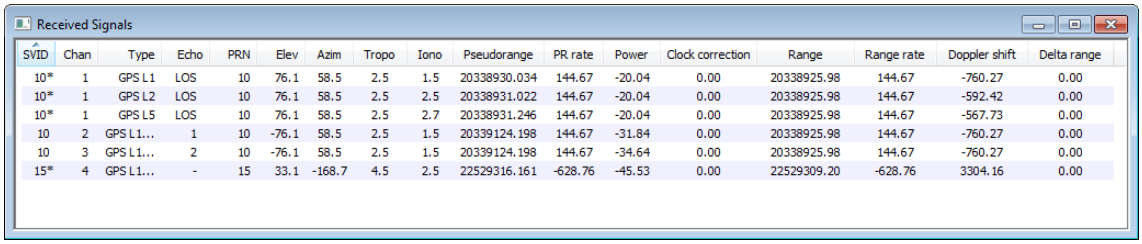
Right-clicking any entry in the table and selecting **Show data for all frequencies** expands the “composite” data in that row into the individual frequency data. For example, right-clicking in the first row of the figure above (**Type-GPS L1L2L5**) and selecting **Show data for all frequencies** displays the data for each of L1, L2 and L5:




| SVID | Chan | Type | Echo | PRN | Elev | Azim | Tropo | Iono | Pseudorange | PR rate | Power | Clock correction | Range | Range rate | Doppler shift | Delta rang |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 7 * | 1 | GPS L1 | - | 7 | -20.0 | 40.5 | -0.0 | 19.8 | 28158684.060 | -3655.20 | 9.23 | 0.00 | 28158664.30 | -3655.20 | 19208.22 | 0.0 |
| 7 * | 1 | GPS L2 | - | 7 | -20.0 | 40.5 | -0.0 | 32.5 | 28158696.843 | -3655.20 | 9.23 | 0.00 | 28158664.30 | -3655.20 | 14967.44 | 0.0 |
| 7 * | 1 | GPS L5 | - | 7 | -20.0 | 40.5 | -0.0 | 35.4 | 28158699.734 | -3655.20 | 9.23 | 0.00 | 28158664.30 | -3655.20 | 14343.80 | 0.0 |
| 15* | 2 | GPS L1L2L5 | - | 15 | 69.9 | -67.8 | 0.0 | 1.7 | 19511301.422 | 2253.33 | 12.42 | 0.00 | 19511299.70 | 2253.33 | -11841.32 | 0.0 |
| 17* | 3 | GPS L1 | - | 17 | -4.1 | 146.8 | -0.0 | 14.7 | 26048565.042 | -2972.96 | 9.91 | 0.00 | 26048550.33 | -2972.96 | 15623.00 | 0.0 |
| 17* | 3 | GPS L2 | - | 17 | -4.1 | 146.8 | -0.0 | 24.2 | 26048574.562 | -2972.96 | 9.91 | 0.00 | 26048550.33 | -2972.96 | 12173.76 | 0.0 |
| 17* | 3 | GPS L5 | - | 17 | -4.1 | 146.8 | -0.0 | 26.4 | 26048576.716 | -2972.96 | 9.91 | 0.00 | 26048550.33 | -2972.96 | 11666.52 | 0.0 |
| 22* | 4 | GPS L1L2L5 | - | 22 | -20.7 | -118.1 | -0.0 | 19.9 | 28261939.223 | 5448.90 | 9.20 | -0.00 | 28261919.34 | 5448.90 | -28634.16 | 0.0 |
| 2 * | 44 | BD2 B1 | - | 2 | -16.8 | 91.0 | -0.0 | 19.5 | 43705156.313 | -6521.19 | 9.59 | 0.00 | 43705136.73 | -6521.19 | 33957.57 | 0.0 |

If your scenario uses multipath signals, right-clicking on the SVID with multipaths and selecting **Show multipath signals for this SVID** displays the data for each multipath signal associated with this SVID. For example, with two multipaths on SVID 10:


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| SVID | Chan | Type | Echo | PRN | Elev | Azim | Tropo | Iono | Pseudorange | PR rate | Power | Clock correction | Range | Range rate | Doppler shift | Delta range |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 10* | 1 | GPS L1 | LOS | 10 | 76.1 | 58.5 | 2.5 | 1.5 | 20338930.034 | 144.67 | -20.04 | 0.00 | 20338925.98 | 144.67 | -760.27 | 0.00 |
| 10* | 1 | GPS L2 | LOS | 10 | 76.1 | 58.5 | 2.5 | 2.5 | 20338931.022 | 144.67 | -20.04 | 0.00 | 20338925.98 | 144.67 | -592.42 | 0.00 |
| 10* | 1 | GPS L5 | LOS | 10 | 76.1 | 58.5 | 2.5 | 2.7 | 20338931.246 | 144.67 | -20.04 | 0.00 | 20338925.98 | 144.67 | -567.73 | 0.00 |
| 10 | 2 | GPS L1... | 1 | 10 | -76.1 | 58.5 | 2.5 | 1.5 | 20339124.198 | 144.67 | -31.84 | 0.00 | 20338925.98 | 144.67 | -760.27 | 0.00 |
| 10 | 3 | GPS L1... | 2 | 10 | -76.1 | 58.5 | 2.5 | 1.5 | 20339124.198 | 144.67 | -34.64 | 0.00 | 20338925.98 | 144.67 | -760.27 | 0.00 |
| 15* | 4 | GPS L1... | - | 15 | 33.1 | -168.7 | 4.5 | 2.5 | 22529316.161 | -628.76 | -45.53 | 0.00 | 22529309.20 | -628.76 | 3304.16 | 0.00 |

Right-clicking in the table header lets you select columns to display and you can sort (low to high, or high to low) after selecting a column.

| | |
|---|---|
| **SVID** | Satellite ID (SVID for GPS). The asterisk, see ID 14* in the above figure, this satellite is one of the four in the “best set” SimGEN uses to calculate the DOP value. |
| **Chan** | Signal generator channel number |
| **Type** | Satellite type and the carrier |
| **Echo** | Multipath signals of an **ID**. Uses “-“ for the incident signal, “1” for the first reflected (multipath) signal, “2” for the second and so on |
| **PRN** | Pseudo-Random Noise sequence associated with the satellite, normally the same as its SVID, except for GPS satellites using the ***Extended GPS constellation*** (page 10-2). |
| **Elev** and **Azim** | Satellite elevation and azimuth angle from the vehicle in degrees. |
| **Tropo** and **Iono** | Additional signal delay (in metres) as satellite signals pass through the Troposphere and Ionosphere. ***Atmosphere file*** (page 9-1) details the Tropospheric and Ionospheric models.<br>For GPS satellites, the data in this window corresponds to L1. Correspondingly, L2 takes precedence over L5.<br>Data for L1, L2 and L5 is available from both remote and run-time logging facilities - see reference qq) and ***Accessing simulation (Quick-Look) data*** (page 25-1) |
| **Pseudorange** | Simulated signal delay, metres. It includes delay due to the free-space distance between the GPS satellite *at time of transmission* and the receiver *at time of reception,* plus Tropospheric and Ionospheric delays; together with other errors and effects, you specify in the scenario.<br>Displays L1 delay if an L1 signal is present in the simulation. |
| **PR Rate** | Rate of change of pseudorange, metres per second |
| **Power** | Simulated signal power, relative to the nominal GPS minimum, in dB.<br>Displays the L1 power level (if the scenario uses an L1 signal) |
| **Clock correction** | Displays the value of the ***Quick look - Signal*** (page 25-6) parameter **Clock correction** |
| **Range** | Displays the value of the ***Quick look - Signal*** parameter **Range** |
| **Range rate** | Displays the value of the ***Quick look - Signal*** parameter **Range rate** |
| **Doppler shift** | Displays the value of the ***Quick look - Signal*** parameter **Doppler shift** |
| **Delta range** | Displays the value of the ***Quick look - Signal*** parameter **Delta range** |

If your scenario uses more than one vehicle and antenna, you can change the current vehicle / antenna and display the **Signals received** window for a different vehicle / antenna, see ***Selecting windows*** (page 3-2).

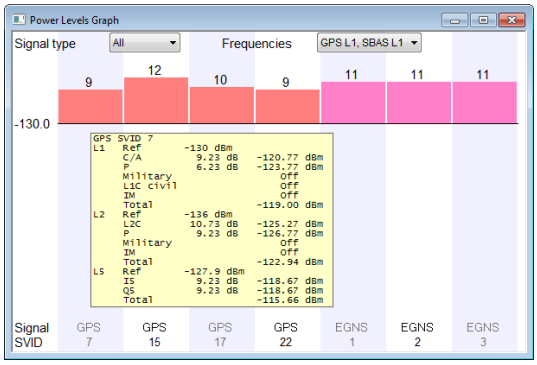

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# 3.8 Power Levels Graph

***Note**: See **CAPS-**Signal control - General (page 17-6) if you use **Code-QPSK** with CAPS satellites*

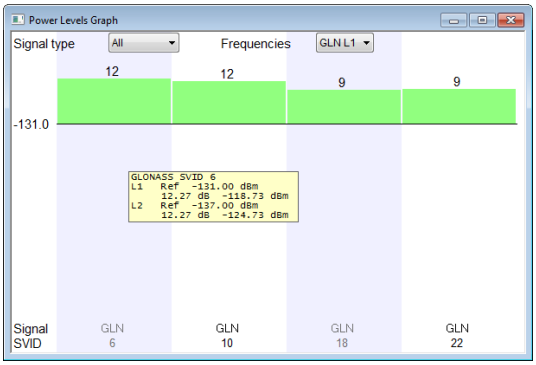
Click the **Power levels** button  on the toolbar to open the **Power Levels Graph** window. The following figures show the signal-level on each channel for GPS, GLONASS, Galileo and BeiDou satellites.

**GPS and SBAS satellites**

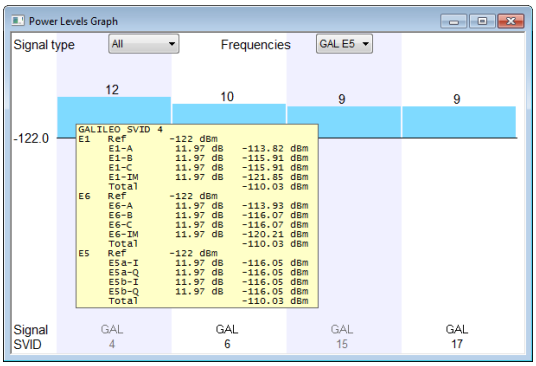



**GLONASS satellites**

***Note**: When you enable GLONASS P-code, SimGEN generates P-code at the same power level as C/A code, but displays only the C/A code RF power level. The total RF power level of a simulated GLONASS satellite using both C/A code and P-code is 3 dB higher than the power level SimGEN shows.*



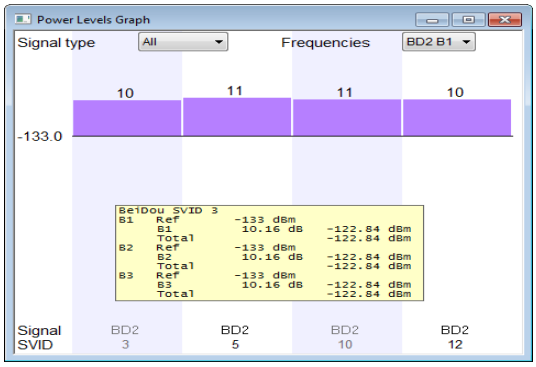

**Galileo satellites**





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**BeiDou satellites**




The window shows the (rounded) signal level in dB above (or below) each vertical bar. This signal level is with respect to the reference level (in dBm) displayed to the left of the horizontal reference line.

The number at the bottom of the screen, below each column, is the SVID of the satellite on that channel, preceded by an indication of the constellation. The SVID column colour coding is the same as that used in ***Sky Plot*** (page 3-4).

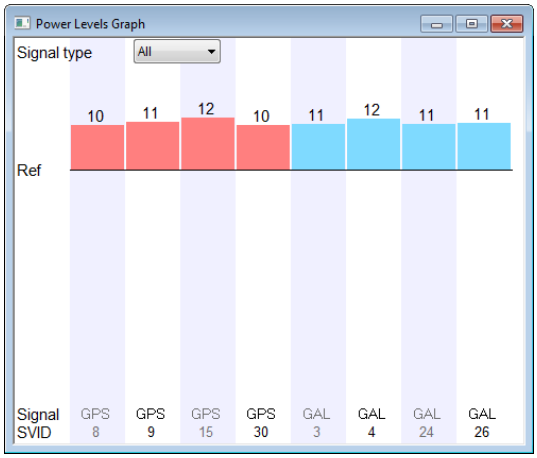
The window for GPS and SBAS satellites (see above) shows satellites from an EGNOS constellation as well as GPS satellites. Satellites you have switched OFF show the text ‘Off’. Satellites obscured from view appear Off but show the text “Obs”.

Clicking on a column displays the RF powers for the PRN code, as shown in the figures below. When more than one constellation is simulated, you can display power levels for each constellation or all constellations using the **Signal type** drop down.

When more than one carrier frequency is simulated, you can display power levels at each carrier frequency using the **Frequencies** drop down menu.

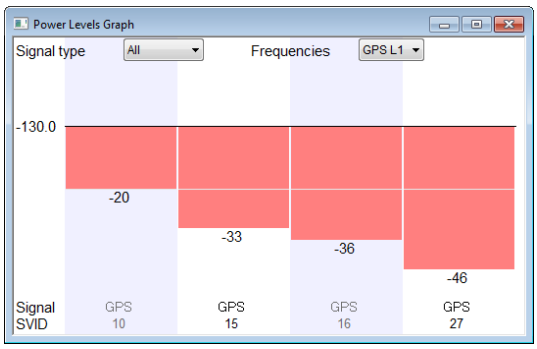
The label for the horizontal reference line shows the reference level in dBm. By default, this is the nominal signal level for the selected carrier frequency. The first figure uses the GPS L1 reference of -130 dBm - see reference c), and the middle figure uses the GLONASS L1 reference of -131 dBm.

If your scenario uses constellations with different reference levels, **Power Levels Graph** shows the text “Ref” instead of a power level in dBm. This figure shows **Power Levels Graph** for GPS L1 (reference level -130 dBm) and Galileo E1 (reference level -122 dBm):




**Power Levels Graph** shows a thin white line at 20 dB below the reference level. This line represents the minimum power accuracy of Spirent signal generators:


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You can set the value your reference line uses using menu item **Options-*General Options*-External power gain** (page 5-15).

Double-click the **Power Levels** window to display the ***Power Adjustment*** (page 3-2) window. You can also select the **Power Levels Adjustment** window from the **View** menu item, or by using the Toolbar button.

If your scenario uses more than one vehicle and antenna, you can change the current vehicle / antenna and display the **Power Levels Graph** for a different vehicle / antenna, see ***Selecting windows*** (page 3-2).

## 3.9 Power Adjustment

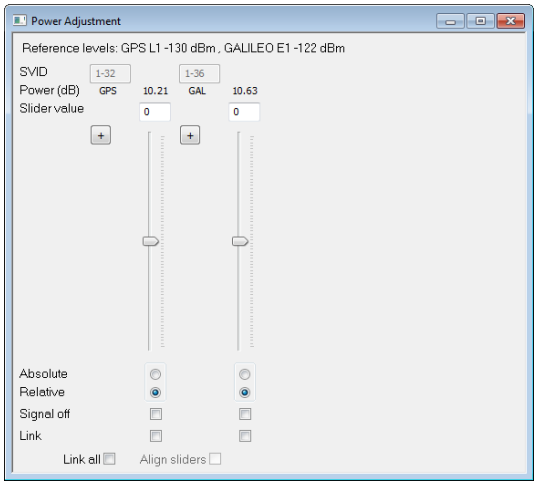
***Notes**:*

***1)** Where this document quotes signal level in dB, it is normally with respect to the appropriate reference level. See the relevant GNSS ICD for details on the appropriate reference levels.*

***2)** SimGEN shows power levels for satellites with RF turned off because you cannot select frequencies in this display. However, **Power Levels Graph** is frequency dependent.*

***3)** The power adjustment sliders continue to function in both **General-Signal Strength-Fixed** or **-Modelled**.*

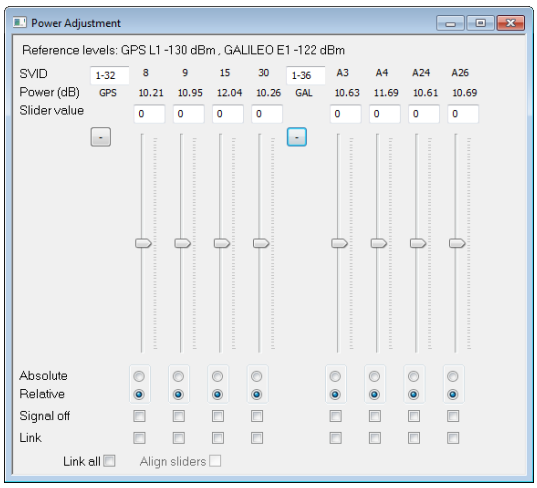
Click the **Power adjustment** button  on the toolbar to open the **Power Adjustment** dialog.




Use this dialog to set the signal level for each simulated satellite (identified using its **SVID**). Each slider adjusts all carrier frequencies currently simulated by that satellite.

Click on the  button to see individual power sliders for each constellation:


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You can use the mouse to drag the sliders, or click above (below) a slider to increment or (decrement) its value by 1 dB. Alternatively, position the mouse on the slider and use the keyboard Page Up Page Down keys to increment/decrement the slider value in 1 dB steps; or use the Up / Down keys for 0.1 dB steps.

The top of the window shows reference level. Modify the reference level using the menu item ***General Options*-External power gain** (page 5-15).

When you specify a scenario, you can set the signal strength as **Fixed** or **Modelled**. In both these modes, the antenna pattern, see ***Receive and transmit antennas*** (page 23-1), modifies the signal level.

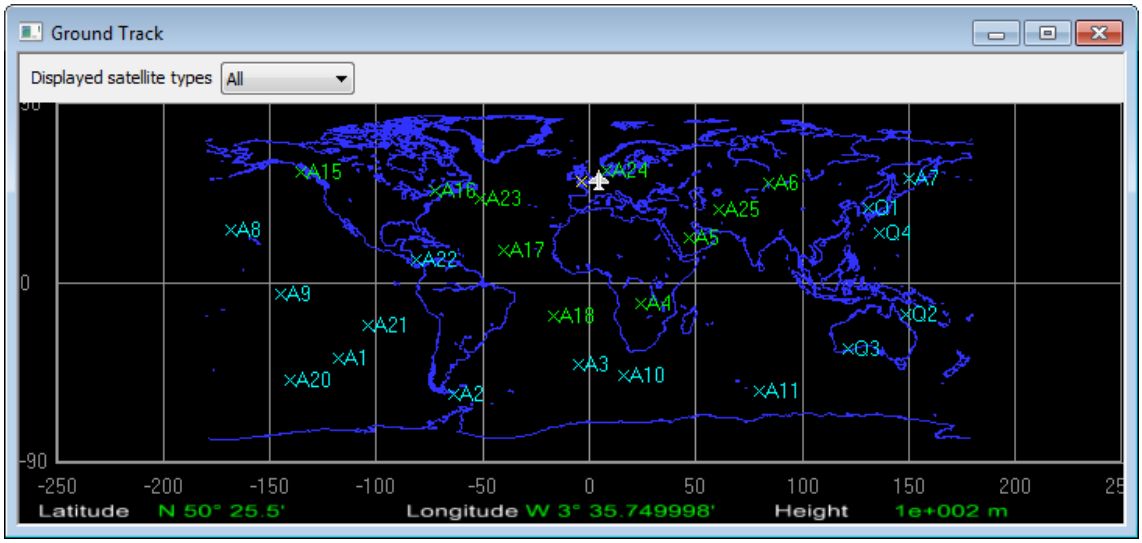
| | |
|---|---|
| **SVID** | Type the range of SVIDs you want to control, using the format <fromSVID>-<to SVID> |
| **Absolute** | Directly applies the level set on the sliders to the output signal.<br>Ignores effects due to any receiver antenna level patterns.<br>Ignores signal-levels from simulation files. |
| **Relative** | Uses the slider values as OFFSETS from the signal-levels you specify in the scenario (adds slider values to the normal simulated signal-levels). The signal truncates to the maximum shown if the base signal plus offset exceeds the maximum available from the signal generator. |
| **Signal Off** | Deselect (default): Signal on that channel is On.<br>Select: Signal on that channel is Off. The signal level displays as 'Off' in the Power Levels window and the slider is disabled. |
| **Link** | Deselect (default): you can set each slider independently<br>Select: all selected sliders move when you set any slider, retaining their offsets |
| **Link all** | Deselect (default): you can set each slider independently<br>Select: all sliders move when you set any slider, retaining their offsets |
| **Align sliders** | Deselect (default): all sliders maintain independent alignment<br>Select: sets all sliders to same horizontal alignment (not necessarily the same power setting) |

If your scenario uses more than one vehicle and antenna, you can change the current vehicle / antenna and display the **Power Levels Graph** for a different vehicle / antenna, see ***Selecting windows*** (page 3-2)

## 3.10 Ground Track

Click the **Ground track** button  on the toolbar to open the **Ground Track** window. This window displays the ground track of the current vehicle on a high-resolution map of the Earth's surface and shows its current **Latitude**, **Longitude** and **Height**.


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The ‘x’ with an adjacent vehicle symbol shows the current vehicle position on a line representing the recent path of the vehicle.

If your scenario uses more than one vehicle and antenna, you can change the current vehicle / antenna and display the **Power Levels Graph** for a different vehicle / antenna, see ***Selecting windows*** (page 3-2). **Displayed satellite types-All** shows satellites from: all constellations. Alternatively, select a constellation from one of those in the drop-down **Displayed satellite types** (SimGEN does not display this drop-down if your scenario uses only one constellation).

**Ground Track** identifies GPS satellites by SVID only. Other constellations identify the satellite using the ***Sky Plot*** (page 3-4) identifiers:

| Constellation | Prefix | Example | Constellation | Prefix | Example |
|---|---|---|---|---|---|
| BeiDou | B | B1 | Ground Tx - GPS | T | T2 |
| CAPS | C | C1 | SBAS - EGNOS | E | E2 |
| IRNSS | N | N2 | SBAS - GAGAN | GN | GN1 |
| Galileo | A | A1 | SBAS - MSAS | M | M2 |
| GLONASS | G | G10 | SBAS-SDCM | S | S3 |
| Ground Tx - GLONASS | TG | TG1 | SBAS - WAAS | W | W2 |
| GPS | (none) | 12 | Quasi-Zenith | Q | Q3 |

**Ground Track** satellite symbol colours:

| Colour | Description |
|---|---|
| Green | Satellite is visible by vehicle.<br>SimGEN is simulating the satellite. |
| Red | Satellite is visible by vehicle.<br>SimGEN cannot simulate the satellite - not enough hardware channels, or the satellite is BANNED (either by using a remote command - see reference qq), or by using **Channel Assignment and Multipath types-*Channel assignment*** (page 24-1)) |
| Cyan | Satellite is not visible by vehicle.<br>SimGEN does not simulate this satellite. |


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Determine the direction of motion along the ground track by opening the **Vehicle Dynamics** window and looking for the vehicle heading that aligns with the current direction of motion.

In the **Ground Track** window:

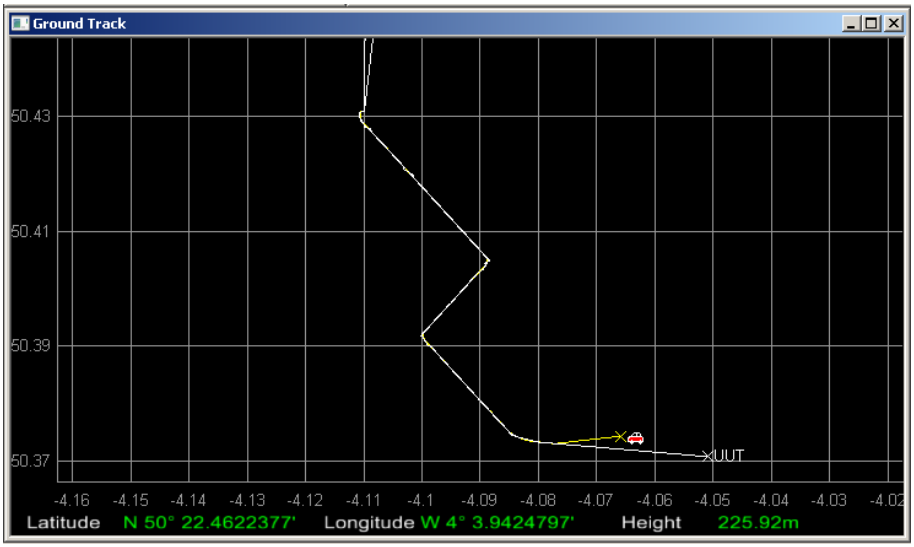
- Use the mouse wheel to zoom in or out of the **Ground Track** window
- Drag the mouse and zoom in to the area (you cannot zoom out using dragging)
- Pan the map (move the map within the window) by holding down the **Shift** keyboard button and dragging the mouse. In the pan mode, the cursor changes to a symbol. You cannot pan the map at **Maximum Zoom Out**
- With the cursor in the **Ground Track** window, right-click to display a context menu with these items:

| | |
|---|---|
| **Zoom In** | Select to zoom in |
| **Zoom Out** | Select to zoom out |
| **Standard Zoom** | The view depends on the extent of the vehicle motion:<br>1) It shows the “whole world” view if the vehicle is static, moving at high velocity or has travelled a large distance.<br>2) It zooms to the area of motion if the vehicle has just started moving, or is moving over a small area. |
| **Max Zoom Out** | Select to view the whole world map |
| **Fixed / Variable aspect ratio** | Fixed (default): Map has constant aspect ratio on zoom or resize<br>Variable: Map aspect ratio changes on zoom or resize. |

### 3.10.1 NMEA receiver position

***Note**: You may need to zoom in before you are able to distinguish the receiver and the vehicle*

If you connect a receiver with NMEA output to the C50r SimGEN Host, **Ground Track** will display the position of the receiver (using a different colour and the label UUT), as well as that of the vehicle:

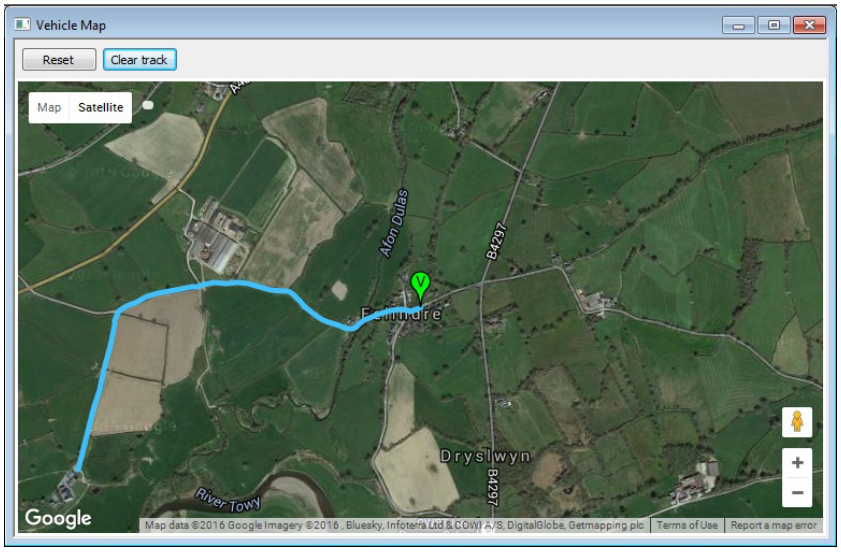



## 3.11 Map window

***Licenced feature**: You will need a SimROUTE licence to use this feature. Contact Spirent for licencing details*

This window displays the route your vehicle is taking during the scenario. It uses a standard Google map view, where you can select either a map or satellite view, for example:


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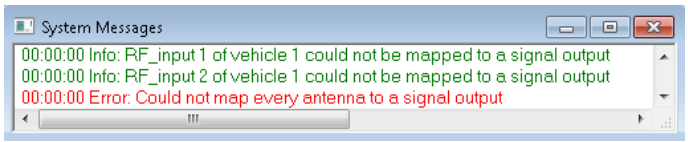



| | |
|---|---|
| **Reset** | Reloads all map data from Google, including terrain, place names and so on |
| **Clear Track** | Clears any vehicle track present on the map |

## 3.12 System Messages

***Note**: The SimGEN_message_log.txt file records every system message.*

Click the **Messages** button on the toolbar to open the **System Messages** window.




System messages use this colour-coding:

| Text colour | Message severity | Text colour | Message severity |
|---|---|---|---|
| Dark Red | Hardware | Grey | Debug |
| Red | Error and Fatal | Blue | Warning |
| Green | Information | | |

When a scenario is running, system messages are time-stamped with time-into-run. When a scenario is not running, the message timestamps will be zero.

You can select the categories of system message using the menu item **Options-*Message Reporting*** (page 5-26). You can also choose to log messages to the log file *[executable filename]_message_log.txt* (located in the current scenario folder).

To clear all messages from the **System Message** window left-click on the icon at the top left of the title bar of the **System Message** window and select **Clear** messages.


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# 4 Configuring scenarios

This Chapter gives details on scenario definition, generation, storage and editing. It includes a tutorial that guides you through creating a basic and advanced SimGEN scenario.

## 4.1 What is a scenario?

When you set up a simulation, you must define certain parameters, including:

- The characteristics of the constellation(s) you want to simulate
- Tropospheric and Ionospheric conditions
- The vehicle type
- The motion of vehicle
- Position of receiving antenna on the vehicle
- Level pattern (gain pattern) of receiving antenna

A scenario is the sum of these definitions. SimGEN allows you to define all relevant parameters and save them as a complete scenario.

You can recall saved scenarios, modify or run them as required.

Some screenshots relate specifically to the GSS9000-series signal generators and the C50r SimGEN Host.

## 4.2 Storing scenarios

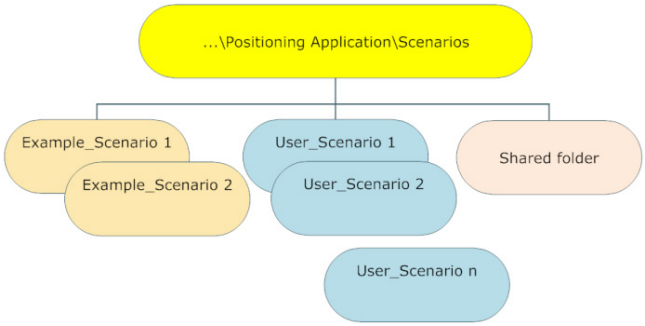
***Note**: Scenarios under a common parent folder may share common files. Common files are stored in a folder named "shared".*

SimGEN stores a scenario as a hierarchy of files (most files are in **.xml* format that you can view with a standard text editor). Each scenario is stored in its own folder (taking the same name as the scenario) under a common parent folder.

For example:

Spirent ships GSS9000-series simulators with the example scenarios in the common "parent" folder *D:\posapp\scenarios*

Spirent normally shipped GSS8000-series and earlier simulators using SimGEN with the example scenarios in the common "parent" folder *C:\Program Files\Spirent Communications\Positioning Application\Scenarios*




By default, SimGEN adds new scenarios under the parent folder. You can set up alternative parent folders for a second user of the system, or for a second project. However, file sharing is only possible for scenarios under a common parent folder, so this isolates the two users or projects.

The top-level (scenario) file takes the scenario extension **.scn*. The scenario name is the same as the folder containing it.

Here is an example **.scn* file:

```
<?xml version="1.0" encoding="ISO-8859-1"?>
<scenario>
    <vehicles> 1 </vehicles>
```


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```
    <veh_file> Aircraft_Example_V1.veh </veh_file>
    <networks> 1 </networks>
    <net_file> Aircraft_Example_TN_GPS.net </net_file>
    <atmos_file> Aircraft_Example_AT1.atc </atmos_file>
    <start_time> 01-Apr-2002 10:00:00 </start_time>
    <duration> 1200 </duration>
    <leap_second_date> 31-Dec-2006 00:00:00 </leap_second_date>
    <rtcm> </rtcm>
    <rtcm_enabled> 0 </rtcm_enabled>
    <nmea> </nmea>
    <nmea_enabled> 0 </nmea_enabled>
    <baro> </baro>
    <baro_enabled> 0 </baro_enabled>
    <user_actions> </user_actions>
    <user_actions_enabled> 0 </user_actions_enabled>
    <user_cmds> </user_cmds>
    <user_cmds_enabled> 0 </user_cmds_enabled>
    <quick_look> default_v1-0.qlk </quick_look>
    <ql_setup_enabled> 0 </ql_setup_enabled>
    <ethernet> data_streaming.dsd </ethernet>
    <ethernet_enabled> 1 </ethernet_enabled>
    <nmea_input> </nmea_input>
    <nmea_input_enabled> 0 </nmea_input_enabled>
    <leap_second_enabled> 0 </leap_second_enabled>
    <yuma> </yuma>
</scenario>
```

This file contains data (scenario start-time and date, duration) plus the names of subordinate files.

## 4.3 Differences between Channel and SVID

You can specify many Commands to use either a Channel or SVID, where:

- Channel refers to a channel in a Spirent signal generator. SimGEN automatically assigns (or you specifically assign) a channel to a satellite (SVID). The number of available channels depends on your signal generator.
- SVID refers to a number (the PRN) identifying a particular satellite, except for GPS satellites using the ***Extended GPS constellation*** (page 10-2). SimGEN assigns an SVID to the next available channel. When an SVID sets, its channel becomes free and available for use by another SVID.

Choosing either Channel or SVID in a command achieves the same result - SimGEN always applies the changes you specify to a signal generator channel, this table outlines the differences between Channel and SVID:

| Parameter | Duration of Parameter settings | Outline of SimGEN actions |
|---|---|---|
| Channel | Remainder of scenario (unless changed) | Automatically applies settings to that Channel.<br>You can change Channel settings during the scenario.<br>During the scenario, SimGEN can assign any SVID to that Channel. |
| SVID | While SVID is visible | At the time of command, SimGEN scans all available channels for the SVID.<br>If the SVID is present, SimGEN applies the settings.<br>If the SVID is not present, SimGEN does not apply the settings. |

The following sections give examples of Channel and SVID settings, giving rules and examples for using Channel or SVID (also known as Tx Channel) using the GPS constellation.

### 4.3.1 Channel settings - rules and example

Channel settings apply for the remainder of the scenario. When SimGEN moves an SVID to a new Channel, it always applies the settings of the new Channel. SimGEN does not retain SVID settings when you move the SVID between Channels, as in this example:



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| Time into scenario | Description |
|---|---|
| Start | SVID 1 set to use Channel 5.<br>Scenario sets Channel 5 to a RF Power Level of -125 dBm. |
| 1 minute | You force SVID 1 onto Channel 9<br>Channel 9 uses its default settings.<br>Channel 5 is available.<br>SimGEN does not retain the -125 dBm RF Power Level when it moves SVID 1 from Channel 5 to Channel 9.<br>SimGEN applies the default RF Power Level for Channel 9 to SVID 1. |
| 2 minutes | SVID 10 rises.<br>SimGEN automatically assigns SVID 10 to the available Channel 5.<br>Channel 5 retains the RF Power Level you set at the start of the scenario.<br>SVID 10 will use -125 dBm RF Power Level. |

If you want to assign a specific RF Power Level to a specific SVID, Spirent recommends you use **Constellation-Signal sources file-Signal control-Signal power**.

### 4.3.2 SVID settings - rules and examples

SVID settings apply only while the SVID is visible. After the SVID sets, SimGEN does not retain non-default SVID settings, as in this example:

| Time into scenario | Description |
|---|---|
| Start | SVID 1 set to Channel 10<br>Channel 10 uses its default settings. |
| 1 minute | SVID 1 set to +20 dB RF Power Level<br>Channel 10 retains the +20 dB Power Level for the duration of the scenario, unless you change its Power Level in the scenario.<br>***Note**: Power Level settings stay with the Channel. Other commands use the default Channel settings when an SVID starts on a new channel.* |
| 2 minutes | SVID 1 moves below the horizon.<br>The constellation cannot use SVID 1 until it rises.<br>SimGEN automatically assigns newly risen SVID 19 to Channel 10.<br>SVID 19 uses the +20 dB RF Power Level previously set. |
| Approximately 12 hours | SVID 1 rises above the horizon.<br>SimGEN automatically assigns SVID 1 to the available Channel 3<br>SVID 1 uses the settings for Channel 3.<br>These will be the Channel 3 default settings unless you have changed them during the scenario. |

To set the RF Power Level of a specific SVID permanently Off, Spirent recommends you remove that SVID from the constellation by deselecting **Constellation-Signal sources file-Motion-Orbits-Present**.

### 4.3.3 Remote commands - run once and move on

***Note**: SimGEN produces an **Information** error message in the **System Messages** window when it runs a remote command for an SVID that is not present in a constellation.*

SimGEN does not check for the presence of an SVID in a constellation before running a remote command. SimGEN runs each remote command once and moves to the next command, as in this example:

| Time into scenario | Description |
|---|---|
| Start | Default setting for SVID 1 is RF On |
| 1 minute | SVID 1 moves below the horizon.<br>The constellation cannot use SVID 1 until it rises. |

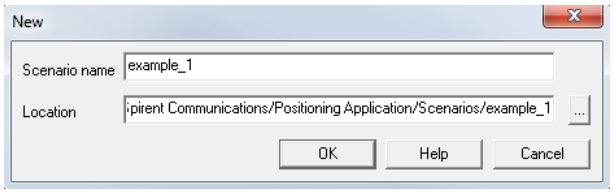

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| Time into scenario | Description |
|---|---|
| 2 minutes | A remote command for SVID 1 sets RF Off.<br>SimGEN runs the command.<br>This command cannot apply to SVID 1 as SVID 1 remains below the horizon (remains set) and so is not in use by the constellation |
| Approximately 12 hours | SVID 1 rises above the horizon with its default setting of RF On<br>The constellation uses SVID1 |

If you want to ensure an SVID appears in a constellation with particular (non-default) settings, Spirent recommends you determine the time the SVID appears in the constellation and apply remote commands at, or just after, this time.

## 4.4 Defining a scenario

Working in the main SimGEN window, select **File-Close** to close all open scenarios. Now select **File-New** and enter the scenario name:



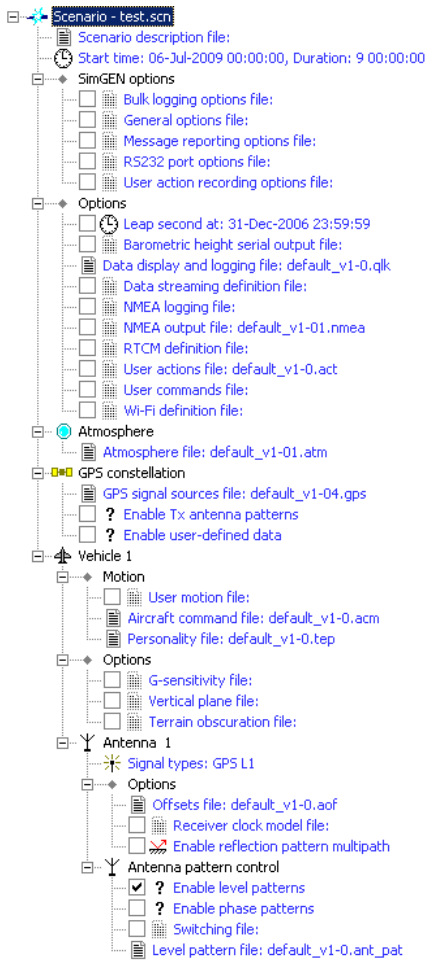

Here the scenario name is ***new***. This example also shows use of an alternative parent folder for the scenario - *C:\SimGEN scenarios*. SimGEN automatically creates a new scenario sub-folder with the same name as the scenario.

### 4.4.1 Scenario contents window

The **Scenario Contents** window, at the left side of the main SimGEN window, displays the scenario and its constituents.

For a new scenario, SimGEN defines default data files and gives them unique filenames. You can view the default data by expanding the scenario, and double-clicking the data filename. This figure shows the **Scenario contents** window with all default files fully expanded for GSS8000-series and earlier signal generators:


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To open the a constellation file editor and view the default data in this file, double-click on the **<constellation>-Signal sources file**, for example **GPS Constellation-Signal sources file-default_vx-yy.gps.** If you change this data and want to use it later on, you must save the modified data and you can change the default filename. You also have the opportunity to save a scenario that contains modified source files. The following table gives the Chapter or section detailing the scenario constituent and a brief description of it.

Some scenarios may need you to enter data in more than one page of the scenario. For example, to use GPS L2C in a scenario:

→ Navigate to **Vehicle-Antenna-Signal Types**

→ Select **L2**

→ Navigate to **GPS Constellation-Signal sources file-Signal control-General**

→ Select **Frequency-L2**

→ Select **PRN-L2C**


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| Scenario constituent | Section or Chapter | Description |
|---|---|---|
| **Scenario description file** | ***Scenario description file*** (page 4-15) | (Optional) Text only file for your notes on this scenario |
| **Start time** | ***Start time*** (page 4-15) | Defines the scenario start time and duration |
| **SimGEN options** | ***SimGEN options*** (page 7-1) | Defines global options associated with all SimGEN scenarios<br>These options override options of the same name in the **Options** menu |
| **Options** | ***Options*** (page 8-1) | Defines options associated with a specific scenario |
| **Atmosphere** | ***Atmosphere file*** (page 9-1) | Defines the atmospheric model detailing the ionosphere and/or troposphere |
| **Constellation** | Each constellation has its own editor:<br>***GPS constellation editor*** (page 10-1)<br>***GLONASS constellation editor*** (page 11-1)<br>***Galileo Open Service constellation editor*** (page 12-1)<br>***Quasi-Zenith constellation editor*** (page 5-15)13-1<br>***SBAS constellation editor*** (page 14-1)<br>***GBAS constellation editor*** (page 15-1)<br>***IRNSS constellation editor*** (page 16-1) | Defines the constellation parameters<br>Scenarios may use more than one constellation type |
| **Vehicle** | ***Vehicle models*** (page 21-1) | Defines each type of vehicle the scenario uses |
| **Vehicle-Motion** | Vehicle models<br>***User motion files*** (page 21-38) | Each SimGEN vehicle model uses a Command file to define the vehicle's motion, and a Personality file to define the "type" of motion (for example defining a Land Vehicle as a Formula 1 racing car or a family saloon).<br><br>***Note****: User motion files do not use SimGEN's vehicle models for motion* |
| **Vehicle-Aiding** | ***INS error model*** (page 22-1) | Defines parameters for up to four INS models |


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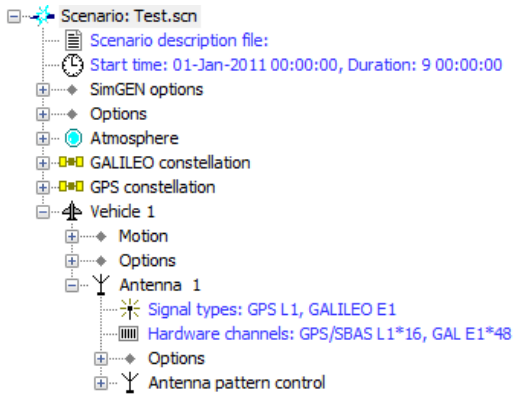
| Scenario constituent | Section or Chapter | Description |
|---|---|---|
| **Vehicle-Options** | Choose from the following:<br>***G sensitivity file*** (page 21-41)<br>***Vertical plane file*** (page 21-41)<br>***Motion sensors file (SimAUTO)*** (page 21-41)<br>***Land mobile multipath*** (page 21-58)<br>***Terrain obscuration file*** (page 21-65) | These options let you define:<br>Sensitivity of the receivers oscillator to G-force<br>Reflections from building surfaces<br>Automotive motion sensors<br>Multipath signals on a mobile phone<br>Effect of terrain on satellite signal |
| **Antenna - Hardware channels** | ***Hardware channels - GSS9000 signal generator*** (page 4-9)<br>***Hardware channels - GSS7000 signal generator*** (page 4-11) | ***Note****: Only visible when using GSS9000-series and GSS7000 signal generators*<br>Shows all channel configurations available for each licenced constellation on each signal generator. |
| **Antenna-Signal types** | ***Associate a GNSS signal with an antenna*** (page 23-4) | Associating the antenna defines the signal type (such as GPS)<br>You can add a second antenna to a vehicle and associate the new antenna with a different constellation |
| **Antenna pattern control** | ***Antenna pattern*** (page 23-9) | Each antenna can have different gain and phase patterns, switchable at different times |


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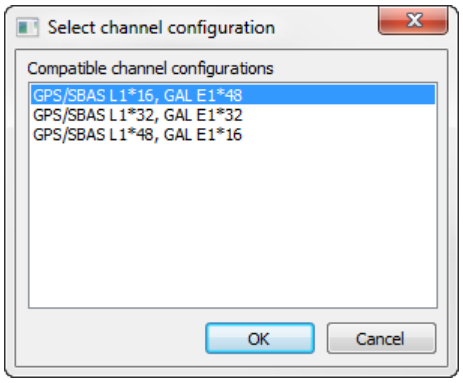
### 4.4.2 Hardware channels - GSS9000 signal generator

***Note**: Only visible when running a GSS9000-series signal generator*

This figure shows the addition of the **Antenna-Hardware channels** parameter to the **Scenario Contents** window:




The scenario in this figure uses the Galileo and GPS constellations in a GSS9000-series signal generator with four channel banks, giving a total of 64 (four channel banks x 16 channels per channel bank) channels available to the Galileo and GPS satellites. This means there are different configurations of channels available and you can select the configuration you want to use by double-clicking **Hardware channels** (the blue text indicates the parameter is editable) to open the **Select channel configuration** dialog:



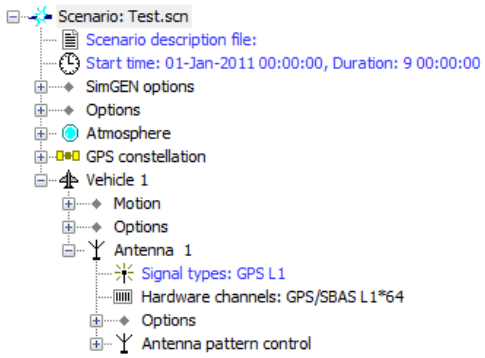

This dialog shows three available configurations. Each configuration has a maximum 64 channels and each configuration has an increasing number of GPS channels and a decreasing number of Galileo channels:

- 16, 32 and 48 GPS channels corresponding to one, two or three channel banks
- 48, 32 and 16 Galileo channels corresponding to three, two or one channel banks

You must select one of the configurations to use in your scenario, this configuration appears in the **Hardware channels** text.

If the **Hardware channel** text is black, as in the figure below (which removes the Galileo constellation from the scenario used for the figure above), there is a unique configuration (64 channels assigned to GPS L1) that you cannot edit:


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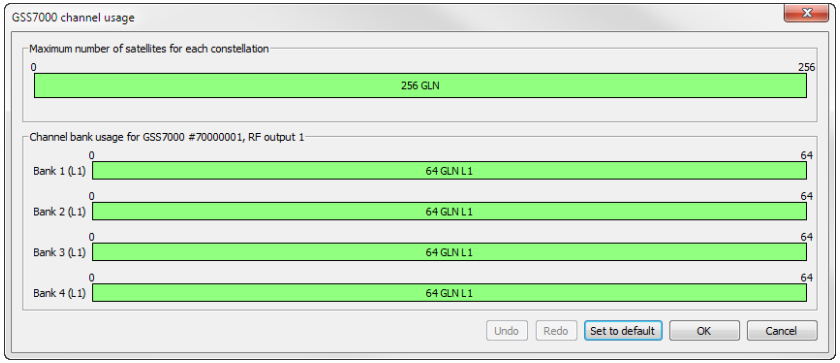
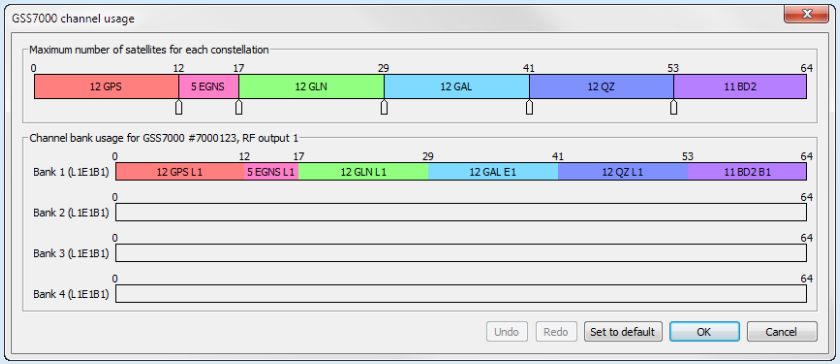
### 4.4.3 Hardware channels - GSS7000 signal generator

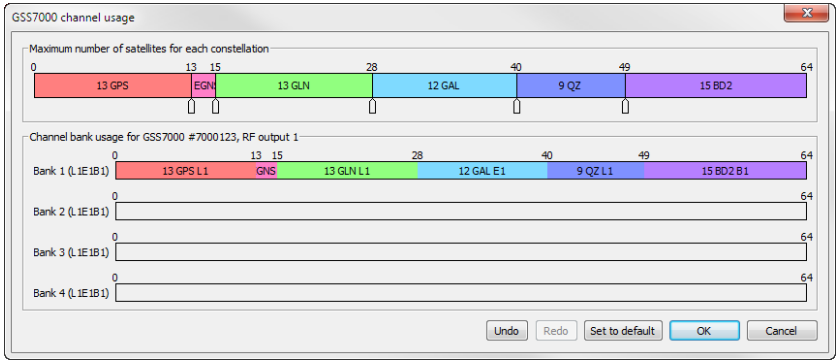
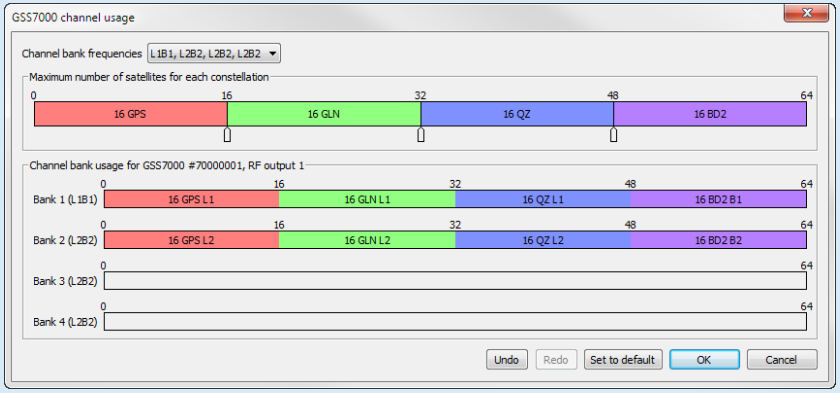
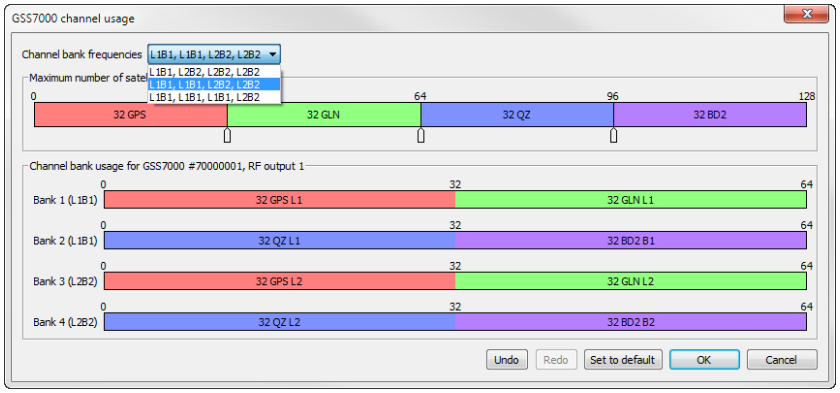
***Licenced feature**: You will need a licence to use this feature. Contact Spirent for licencing details*

***Note**: SimGEN enables **Hardware channels** only for GSS7000 signal generators*

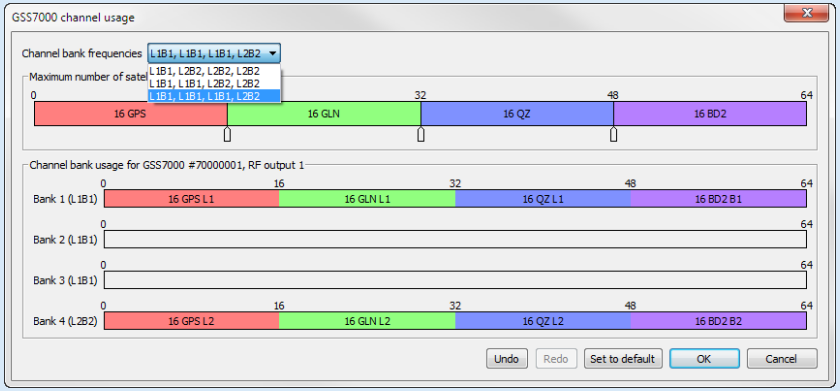
Double-clicking **Hardware channels** opens the **GSS7000 channel usage** dialog.

This dialog lets you control how SimGEN assigns channels between each constellation in your scenario. For example:

| Description | GSS7000 channel usage dialog |
|---|---|
| GSS7000 installed with the maximum four channel banks (supporting up to 64 channels per channel bank, one frequency band per channel bank).<br>This figure uses a licence for 256 channels and the GLONASS L1 constellation. All four channel banks are in use.<br><br>If this GSS7000 had a single channel bank installed, this dialog would only show **Bank 1** populated with 64 GLONASS L1 channels. |  |
| One channel bank - maximum 64 channels.<br>This example uses a licence for 64 channels and the constellations BeiDou B1, Galileo E1, GLONASS L1, GPS L1, EGNOS L1 and Quasi-Zenith L1.<br>SimGEN initially divides the available channels equally between constellations, giving fewer channels to SBAS constellations (where present).<br>Sliders in the area **Maximum number of satellites for each constellation** let you adjust the channels assigned to each constellation. |  |

| Description | GSS7000 channel usage dialog |
|---|---|
| This figure shows that reducing the number of Quasi-Zenith channels to nine increases the number of BeiDou channels to 15 (the total channels remain at 64) |   |
| GSS7000 installed with the maximum four channel banks (supporting up to 64 channels per channel bank, one frequency band per channel bank).<br>This figure uses a licence for up to 256 channels and the BeiDou B1 and B2, GLONASS L1 and L2, GPS L1 and L2, and Quasi-Zenith L1 and L2 constellations.<br><br>Notice the number of satellites in a constellation remains the same across the frequency bands |   |
| Using the same details as above, the **Channel bank frequencies** drop-down lets you move the L2 and L5 frequencies between different channel banks<br>Notice the number of channels assigned to a constellation remains the same across the frequency bands |   |


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| Description | GSS7000 channel usage dialog |
|---|---|
| Using the same details as above, the **Channel bank frequencies** drop-down lets you move the L2 and L5 frequencies between different channel banks<br>Notice the number of assigned to a constellation remains the same across the frequency bands |  |



| | |
|---|---|
| **Undo** | (Keyboard shortcut CRTL+Z)<br>Undoes any changes you have made using the sliders |
| **Redo** | (Keyboard shortcut CRTL+Y)<br>Re-applies the changes you made using the sliders |
| **Set to default** | Set to the default of equal channels per constellation.<br>(Notice SBAS constellations use a small number of channels) |
| **OK** | Save slider settings and close dialog |
| **Cancel** | Do not save slider settings and close dialog |

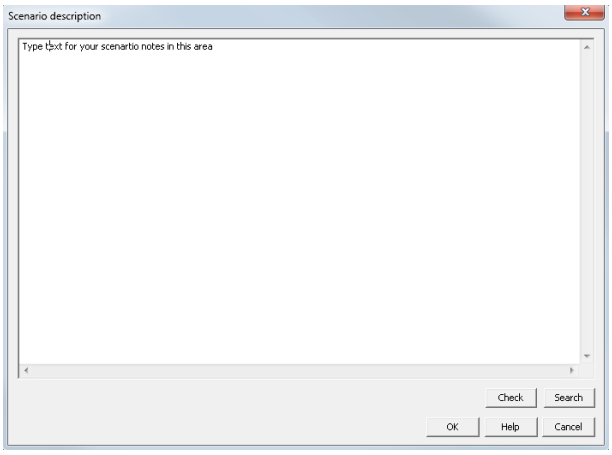

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### 4.4.4 Scenario description file

This is an optional, text-only, file using extension **.dsc*. You can use this file, for example, to create notes on the scenario. The **Scenario description file** is stored in the current scenario folder. This figure shows an example file *my notes.dsc*:

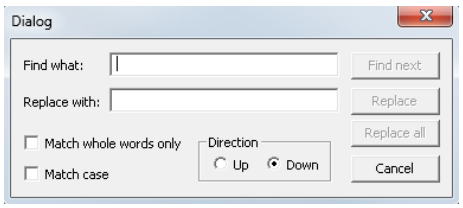



Enter details into a Scenario description file by highlighting **Scenario description file** in the **Scenario contents** window and then double-click to open the file editor.

Type your text in the editor.

Click **OK** to save the file in the current scenario's folder using a name of your choice.

Click **Search** to open the **Find and Replace** dialog:




Type a word or phrase in the **Find what** text box and click **Find next**. The search starts from the current position of the cursor in the **Direction** you select (default is **Down**) and highlights the first instance of the word or phrase. You can replace this word or phrase with the text you type in the **Replace with** text box by clicking **Replace**, which replaces the highlighted text; or click **Replace all** to replace every occurrence of the word or phrase in the **Find what** text box without additional confirmation.

You can select whether to **Match whole words** in the **Find what** text box and whether to **Match the case** of the text in the **Find what** text box.

**Check** is currently disabled.

Click **OK** to save the changes. Click **Cancel** to discard all changes.

### 4.4.5 Start time

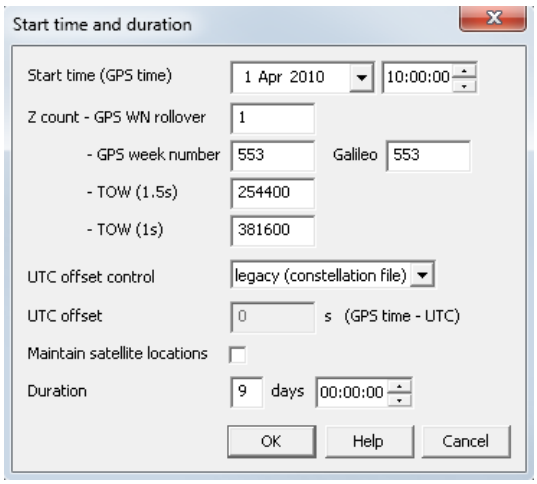
***Notes:***

***1)*** *From SimGEN v2-61 on, the start time of a new scenario is 00:00:00 on the day of creating the scenario. The SimGEN Controller's internal clock determines the day*

***2)*** *WN rollover changes from "1" to "2" on midnight 7 April 2019.*

To change the scenario start time or duration, open the **Start time and duration** dialog by double-clicking **Start Time** in the **Scenario Contents** window:


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| | | |
|---|---|---|
| **Start time** | Enter the start time of the scenario<br>The **Z-count** parameters automatically change to reflect your new **Start time** | |
| | Units: date hh:mm:ss.ss | Range:<br>06 January 1980 00:00:00.00<br>to<br>06 January 2048 23:59:59.00 |
| **Z-Count**<br>**GPS WN rollover**<br>**GPS week number**,<br>**Galileo**,<br>**TOW (1.5s)** and **TOW (1s)** | Displays the **Start time** in **GPS** (and **Galileo** format if your scenario uses Galileo) | |
| **UTC offset control** | ***Note**: SimGEN does not use the leap second values in the Leap seconds history.txt file to set a leap second event during a scenario.*<br>*To simulate any leap second event, you must use <**scenario name**>-Options-Leap second (page 8-1)*<br><br>Choose from:<br>**automatic** (default) SimGEN automatically applies the appropriate UTC offset value at your scenario start time using data from the file *Leap seconds history.txt* in the default folder: *D:\posapp\software\<version>\gui \Datum Files*<br>(for GSS8000-series and earlier signal generators the default folder is *C:\Program Files\Spirent Communications\Positioning Application\Datum Files).*<br>SimGEN shows this value in the **UTC offset** area.<br>**UTC offset control-automatic** uses the UTC offset from the *Leap seconds history.txt* file<br><br>**legacy (constellation file)** Spirent recommend you only use **legacy** to provide backwards compatibility for scenarios created with SimGEN up to version 2-90. Spirent recommend you always use the default **automatic** for scenarios created with SimGEN 2-90 onwards<br>**fixed value** (enables **UTC offset**) type the **UTC offset** you want to use | |

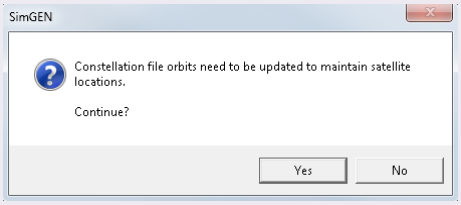
***Notes:***

***1)** Spirent will update the leap seconds history.txt file for new SimGEN releases where a leap second change is appropriate. You can update this file as required. Updates to this file may result in small changes in the characteristics of existing scenarios where the start time is after the latest leap second event. If this is likely to cause a problem in terms of test repeatability, Spirent recommends you use **UTC offset-fixed value**.*

***2)** If you load a Rinex file with more than one dataset for a satellite, SimGEN loads the most recent dataset (this is the dataset closest to the bottom of the file) and ignores all preceding datasets.*

***Note when reading from Rinex files:** You must select **Scenario-Start time-UTC offset-legacy (constellation file)** (page 4-15) before SimGEN can read leap seconds from Rinex files. If you do not select **legacy(constellation file)**, SimGEN will use your entry in **Scenario-Start time-fixed** or the value in history.txt if you selected **Scenario-Start time-automatic***


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| | | | |
|---|---|---|---|
| **UTC offset** | Disabled: Displays the current UTC offset value SimGEN applies for **UTC offset-legacy (constellation file)** or **- automatic**.<br>Enabled: Type the number of integer offset seconds you want to use for **UTC offset-fixed value**. The text in brackets reminds you **UTC offset** is GPS time minus UTC time | | |
| | Units: seconds | Range: -128 to 127 s (integer steps) | Default: 0 |
| ***Note when writing to Rinex files:*** *The value SimGEN uses for UTC offset depends on your selection in* ***Scenario-Start time-UTC offset****, as follows:*<br>***-fixed****: SimGEN writes the value from your entry for* ***UTC offset*** *to the Rinex file*<br>***-automatic****: SimGEN writes the value from the history.txt file it uses*<br>***-Legacy (constellation file)****: SimGEN writes the value you specify in* ***General-GPS time leads UTS by*** | | | |
| **Maintain satellite locations** | Deselect (default): Calculates satellite positions using the new **Start time**<br>Select: Keeps the positions of all satellites in each constellation your scenario uses at the positions defined by the original **Start time**. After you enter a new **Start time** and click **OK**, SimGEN prompts you to update the orbit of each constellation file:<br>  | | |
| Clicking **Yes** | Saves a new version of the signal sources file for each constellation in your scenario, using this dialog:<br>  | | |
| Clicking **No** | Does not update the file(s) and returns to the previous dialog | | |
| **Duration** | Enter the duration of the scenario.<br>If you exceed the maximum value, SimGEN shows the range limits. | | |
| | Units: d hh:mm:ss.ss | Maximum: 23d 23:59:59 | Default: 9 d |

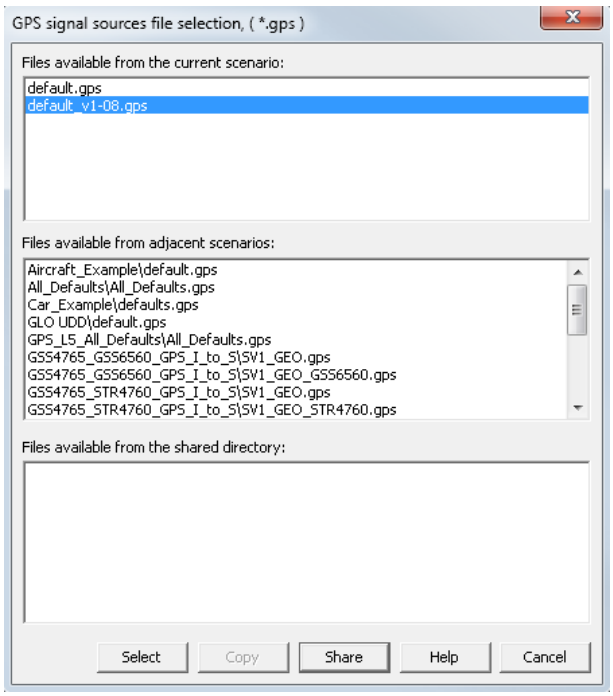
## 4.5 Adding files to a scenario

This example describes adding a new GPS signal sources file. Currently this example scenario uses **GPS constellation-Signal sources file-default.gps**.

To select a new file:

- → Select the GPS signal sources file.
- → Right-click and select **Select**.
- → Highlight the file you want to add - *default_v1-08.gps*.
- → Click **Select** to add this file to the Signal sources file.
- → Save the modified scenario using **File-Save As**.


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The **Select** file dialog displays all available files in three areas:

| | |
|---|---|
| **top** | files in the current scenario folder |
| **middle** | files in other scenario folders having the same parent folder |
| **bottom** | shared files from the “shared” folder under the common parent folder. |

You can **Select** or **Share** a file in the top area - Files **available from the current scenario**. Selecting **Share**, copies the file to the “shared” folder and scenario references that file.

You can **Copy** or **Select** a file in the middle area - **Files available from adjacent scenarios**. Selecting **Copy** copies the file to the current scenario folder and the scenario references that copy.

You can **Copy** or **Select** a file in the bottom area - **Files available from the shared directory**. Choose **Select**, to reference the shared file in the scenario. Select **Copy** to copy the file to the current scenario folder and reference the copy in the scenario.

This dialog allows you to share common files for a group of scenarios, or to take copies of files in existing scenarios. You can modify the copy of the file without changing the original file or scenario.

### 4.5.1 Editing the selected files

***Note**: Before you save a Shared file, SimGEN warns you that editing a Shared file will change all scenarios using that Shared file. SimGEN does not prevent you modifying the Shared file.*

You can edit a set of files for the scenario by either:

- → Double-clicking on the file name in the **Scenario contents** window, or
- → Clicking on the filename to select it then click **Edit** at the foot of the **Scenario contents** window, or
- → Clicking on the filename to select it then right-click and select **Edit**.

## 4.6 Scenario construction tutorial

This is a guide for setting-up and running a scenario using GPS satellites. After you generate the basic scenario, we move onto more advanced options. This tutorial covers the different ways to get your data into SimGEN. This tutorial does not cover every SimGEN dialog you may see.

Screenshots show the scenario results and there are cross-references to the appropriate sections in this manual.

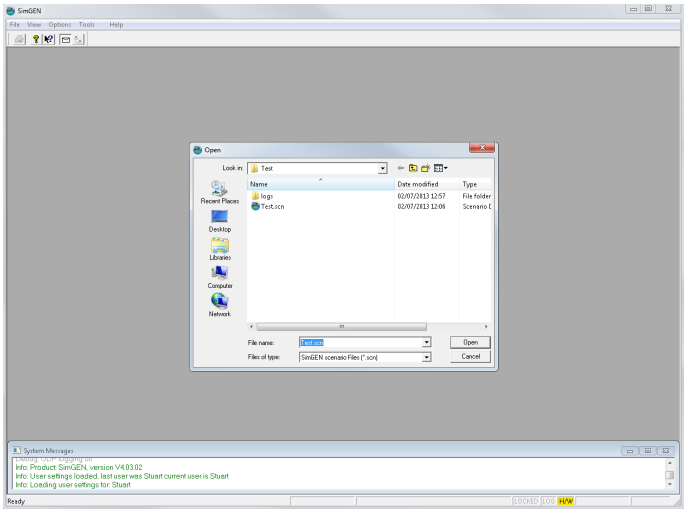

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### 4.6.1 Set up a basic scenario

This table shows the steps in setting-up the example scenario:

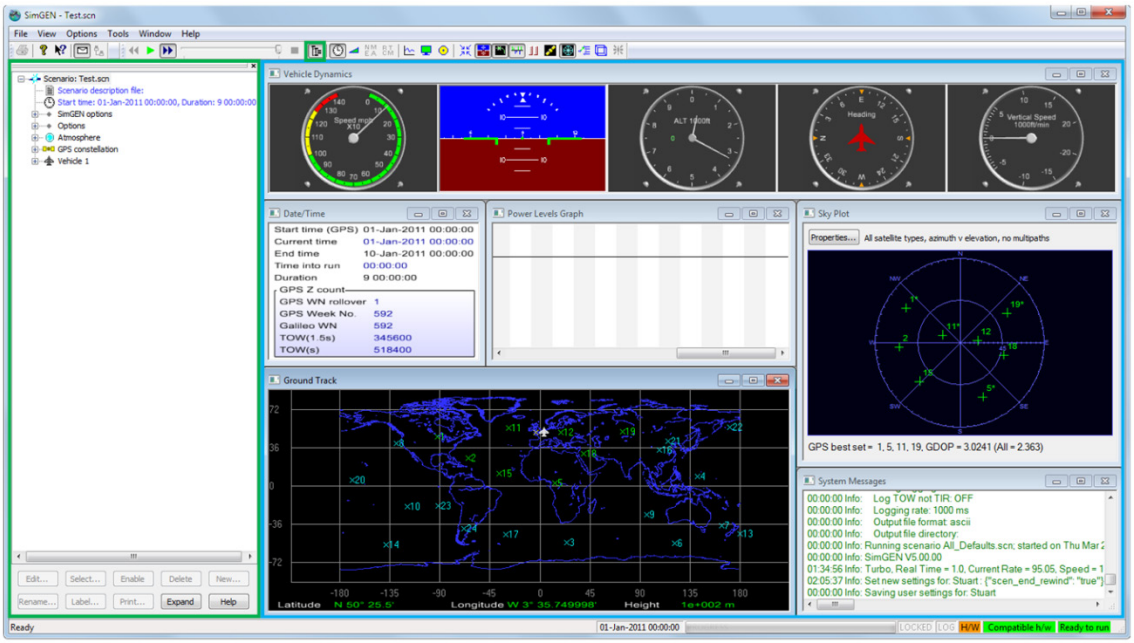
| Step | Description |
|---|---|
| 1 | ***Create a new scenario*** (page 4-21) |
| 2 | ***Create a scenario description file*** (page 4-22) |
| 3 | ***Change the start time and duration*** (page 4-22) |
| 4 | ***Change vehicle type*** (page 4-23)<br>Change: Aircraft |
| 5 | ***Create an Aircraft command file*** (page 4-24) |
| 6 | Set Location: South-West England (as a Waypoint in the command file) |
| 7 | ***Enable EGNOS satellites*** (page 4-26) |
| 8 | ***Logging data*** (page 4-27) |

Start SimGEN by double-clicking on the desktop icon. SimGEN opens with the display in the figure below. Notice the **Open** dialog displays the last scenario you used.



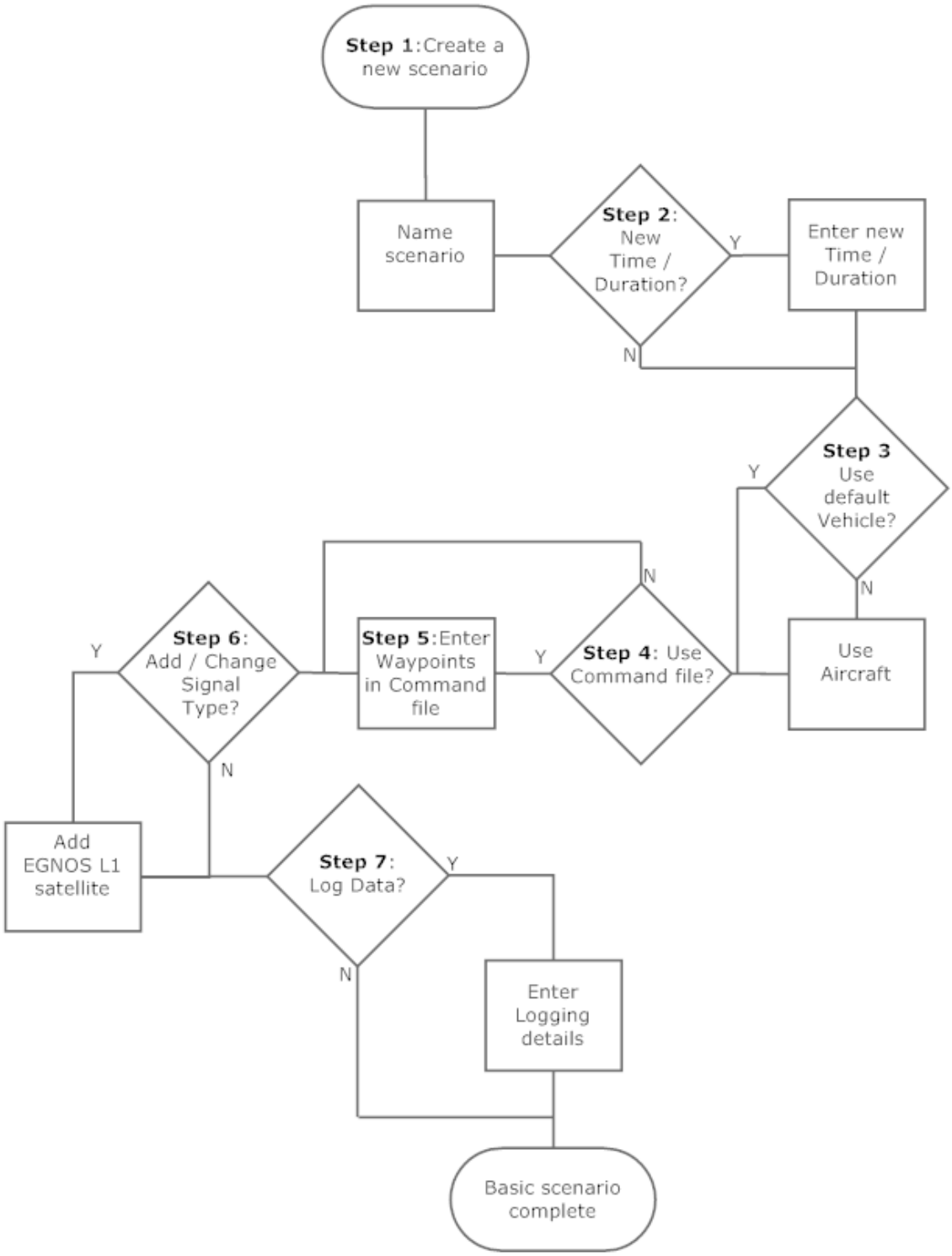
After selecting a scenario, SimGEN starts with its default windows in the main area (blue rectangle in the figure below) and with an open Scenario contents window on the left-hand side (green rectangle). If you cannot see the **Scenario contents** window, click the **Scenario contents** tool bar button  , highlighted with a green square:


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Here is a flowchart of the steps we shall take to create this basic scenario:


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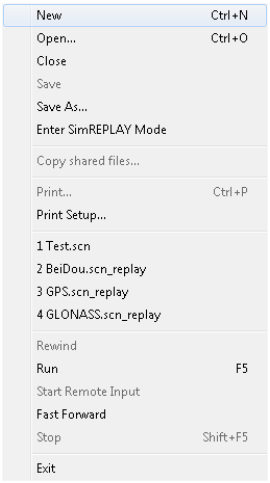



First, we will create a new scenario.

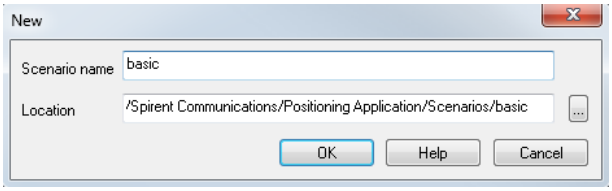
#### 4.6.1.1 Create a new scenario

Working in the main SimGEN window, click **File-New**:


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In the **New** dialog type a **Scenario name**, we use *basic*, with the default **Location**.




The default location for scenario files is a sub-folder of the *Scenarios* folder with the same name as your scenario. In our case, the folder name is *basic*. The location of the *Scenarios* folder is *C:\Program Files\Spirent Communications\Positioning Application\Scenarios.*

You now have a new scenario. SimGEN uses a default (static) vehicle, which we shall change later.

Working in the scenario contents window, ensure the scenario *basic* is fully expanded.

#### 4.6.1.2 Create a scenario description file

This is an optional text-only file. You may use it, for example, to store notes about your scenario, parameters you intend to use and so on.

We will not use a scenario description file in this tutorial.

#### 4.6.1.3 Change the start time and duration

***Notes**:*

***1)** From SimGEN v2-61 on, the start time of a new scenario is 00:00:00 on the day of creating the scenario. The SimGEN Controller's internal clock determines the day.*

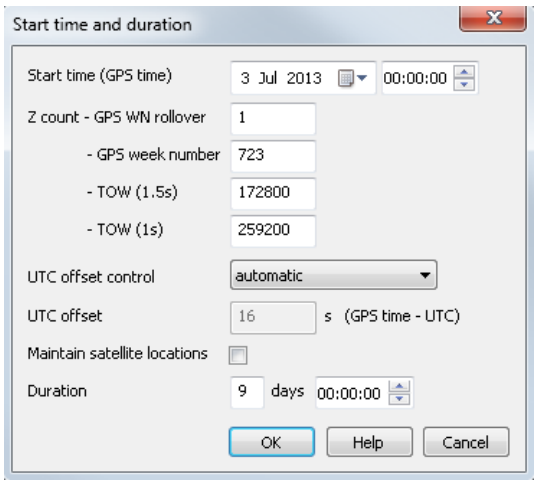
***2)** WN rollover changes from one to two on midnight 7 April 2019.*

We will change the scenario start date, time and duration to a date, time and duration of your choice.

Open the **Start Time and Duration** dialog by double-clicking ***Start time*** (page 4-15) in the **Scenario Contents** window:



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Click in the **Start time** date box and type the date you want to use, using the “long” date format (enter the day, month and year in full as in the figure above. Alternatively, click on the down arrow to the right of the date box and select the start date using the calendar. Click on the left or right arrow buttons to move through the months, then click on a day to select it. Notice WN rollover, Week number and the TOW (1.5s) and TOW (1s) values in the dialog update automatically.

Set the hours, minutes and seconds of the start time by clicking on the relevant group of double zeroes (these are in “hh:mm:ss” format) in the time box, to the right of the date box. Type in the time you want, or select the time by clicking on the up / down arrows. Notice WN rollover, Week number and the TOW (1.5s) and TOW (1s) values in the dialog update automatically.

Enter the Duration (of the scenario) in the same way you entered the start time. The Duration is in the format “days hh:mm:ss” from the Start time. SimGEN has a Duration limit of 23 days 23:59:59. If your Duration exceeds this limit, SimGEN gives an out of range warning in the dialog. This warning includes the acceptable range for the parameter you want to use. Alternatively, type the Week number, the TOW (1.5s) or the TOW (1s) and Start time will show the correct time and date.

Leave **UTC offset control** at its default setting (**automatic**).

Leave **Maintain satellite locations** deselected.

#### 4.6.1.4 Change SimGEN options and Options

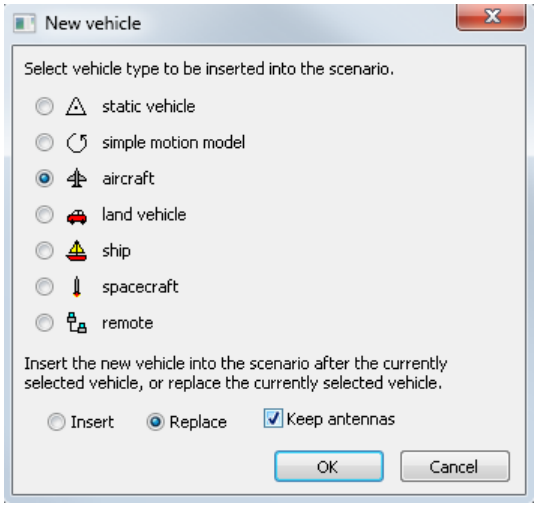
We will not change parameters in either of these two Options.

#### 4.6.1.5 Change vehicle type

We will change the vehicle type from SimGEN’s default, a static vehicle, to an aircraft.

There are two ways to open the **New vehicle** dialog: either select **Vehicle** in the **Scenario contents** window and click **New** at the bottom of the **Scenario contents** window, or hover over **Vehicle**, right-click and select **New**.

This figure shows the **New vehicle** dialog:




Select aircraft, then select **Replace** and select **Keep antennas**. Selecting **Keep antennas** transfers the antenna configuration from the current (static) vehicle to your new vehicle (aircraft). Click **OK**.


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Not selecting **Keep antennas** means you must set up all antenna details including defining the type of signal (GPS, GLONASS and so on) you want to use.

You can add extra vehicles by selecting **Insert** instead of **Replace**. When you insert an extra vehicle, you must set up the antenna details for this vehicle. Be aware that if you use more than one antenna your signal generator must be able to provide multiple outputs, unless you are using **No hardware** mode. Reference mm) details Spirent signal generators.

#### 4.6.1.6 Create an Aircraft command file

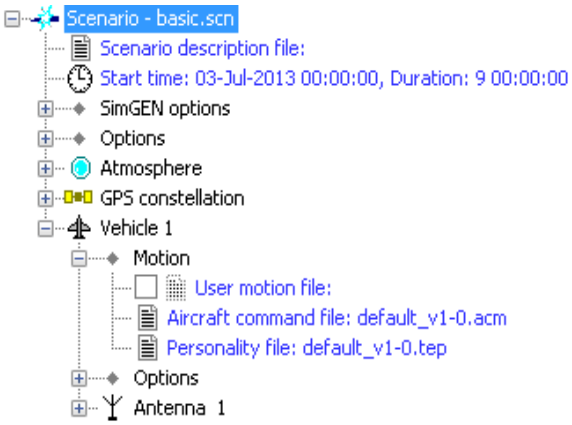
***Note**: You must manually build the Command file list in the order you want. SimGEN does not automatically order these actions.*

The Aircraft command file is a sequence of manoeuvres. Each command (with the exception of the Waypoint command) is relative, not absolute (that is, use “turn 90°”, not “turn to a heading of 180°”). This allows you to insert or delete commands at any point in the sequence, within the model’s capability.

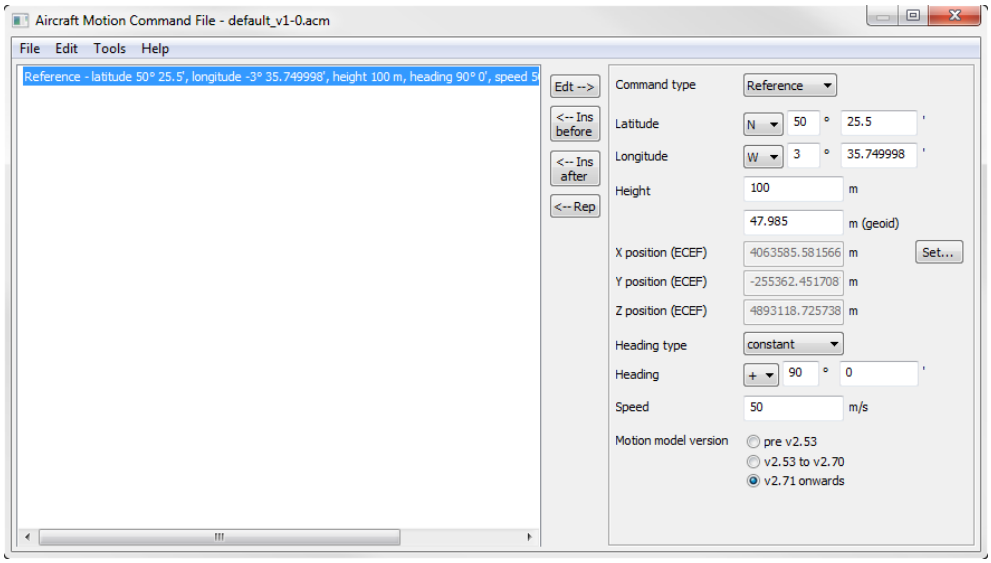
The Personality file specifies the characteristics of the aircraft. In a more advanced scenario, you can use a Personality file to make the aircraft behave like an airliner or a fast responsive fighter. For example, creating a Personality file that specifies a slow roll-rate means the aircraft will take longer to roll to the required bank angle for a turn, so modifying the duration and radius of the turn.

***Vehicle models*** (page 21-1) details all SimGEN’s vehicle models.

To create an Aircraft command file, work in the **Scenario contents** window and expand **Vehicle**, then expand **Motion**:




Edit the Aircraft command file by highlighting it and double-clicking, by highlighting it and clicking **Edit**, or by hovering over it, right-clicking and selecting **Edit**. The SimGEN ***List Editor*** (page 5-33) opens showing parameters specific for the Aircraft command file. Notice the first line is the **Reference** command:



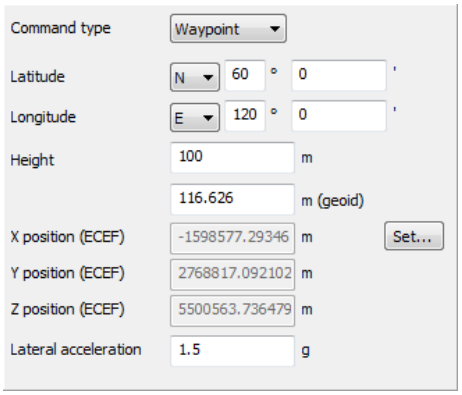

The left-hand area of the editor shows the commands the Aircraft motion file will run. Notice the left-hand area contains a default **Reference** command. **Reference** defines the aircraft’s position at the start of the scenario and specifies the initial heading and speed (velocity). For this scenario, do not change **Reference**.


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The commands in the left-hand area will run in the order shown, so you must take care to build the list in the correct order. Later, we will add more commands to this list.

The right-hand area details the available commands in **Command type**. The parameters for each command appear beneath **Command type**. The vehicle you choose selects these parameters and their ranges.

Now we shall create the first **Waypoint**. Select **Command Type-Waypoint** and type the information as shown below:

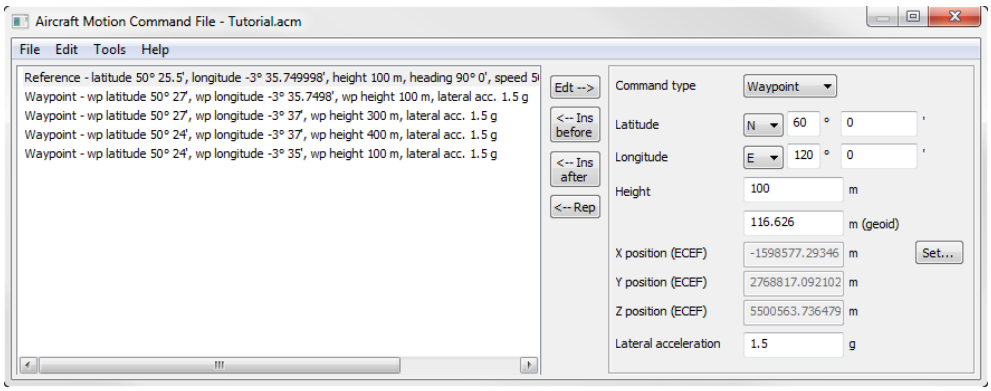



Click **Ins after** to insert this information into the Aircraft command file. Notice that if you click **Ins before** the editor takes no action, as the default **Reference** command must be the first command in the list.

Next, create three more **Waypoints** with the following data (use the default value of lateral acceleration):

- Waypoint 2: latitude 50° 27' North, longitude 3° 37' West, height 300m
- Waypoint 3: latitude 50° 24' North, longitude 3° 37' West, height 400m
- Waypoint 4: latitude 50° 24' North, longitude 3° 35' West, height 100m

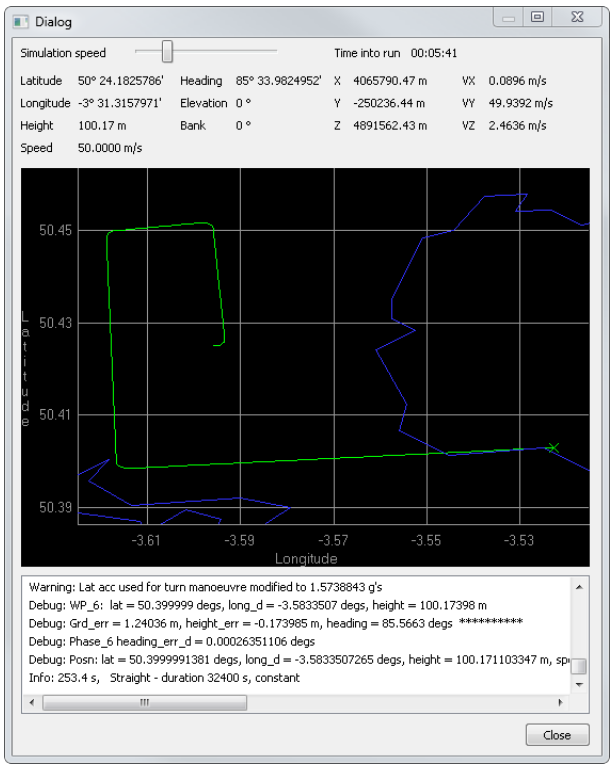
Now save this file. Click the menu item **File-Save as** in the File editor window. Enter the file name *tutorial.acm*. Your Aircraft command file contains the entries shown in this figure:




Before using this new Aircraft command file, we will use a SimGEN utility to check for valid commands in the Aircraft command file. This is sensible because the aircraft has a limit to its turning radius and if the Waypoints are too close, the aircraft will not be able to fly between them.

With your file open in the Aircraft Motion Command file editor, click on **Tools** and select **Check all**. The window below appears and automatically starts the check. Notice the aircraft continues on its current heading (heading in an Easterly direction over Europe and Asia) after the last **Waypoint**. Terminate the check any time after the turns in the figure below by clicking **Close**. You can change the **Simulation speed** using the slider. The section **Vehicle models-Aircraft-*Check all utility*** (page 21-16) details using this utility.

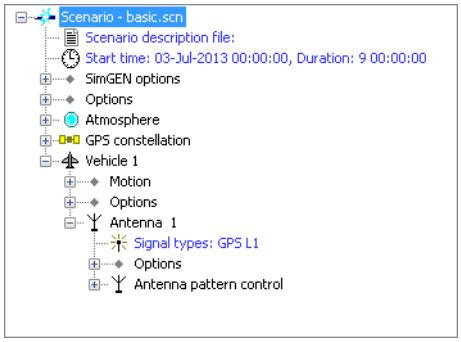

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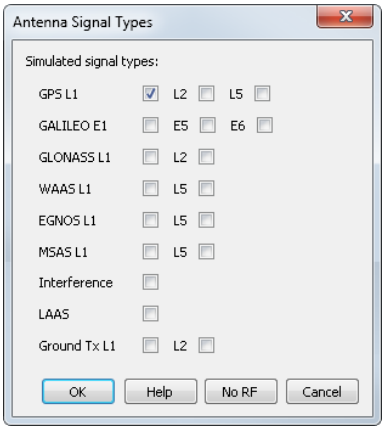

### 4.6.1.7 Enable EGNOS satellites

Now we will set the scenario to use a second signal type - the L1 carrier from an EGNOS satellite:

In the **Scenario contents** window, expand **Vehicle-Antenna**:

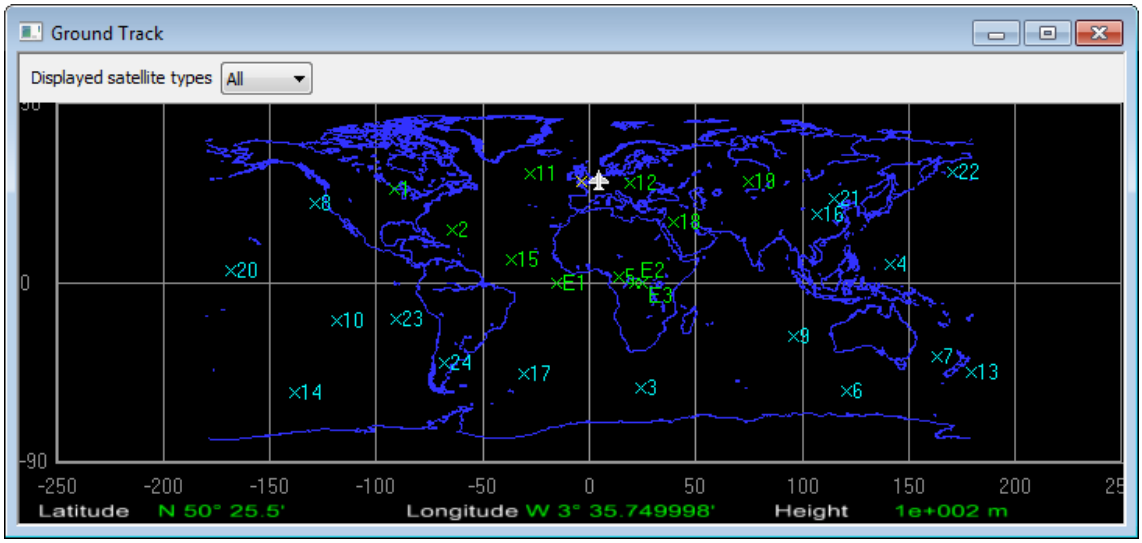


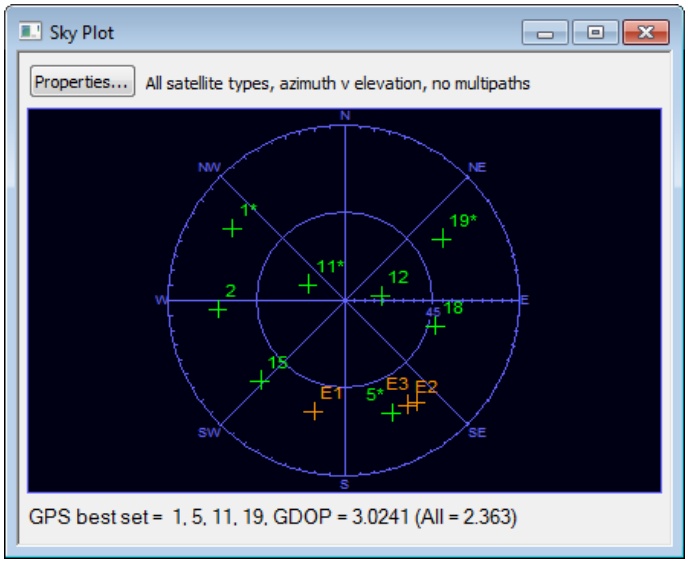

Open the **Antenna Signal Types** dialog, by highlighting it and double-clicking it, by highlighting it and clicking **Edit**, or by hovering over it, right-clicking and selecting **Edit**. This figure shows a typical dialog:




→ Select the EGNOS L1 carrier and click OK.
EGNOS satellites appear in the **Ground Track** and **Sky Plot** windows preceded with 'E':


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*SBAS constellation editor* (page 14-1) gives more details on EGNOS.

### 4.6.1.8 Logging data

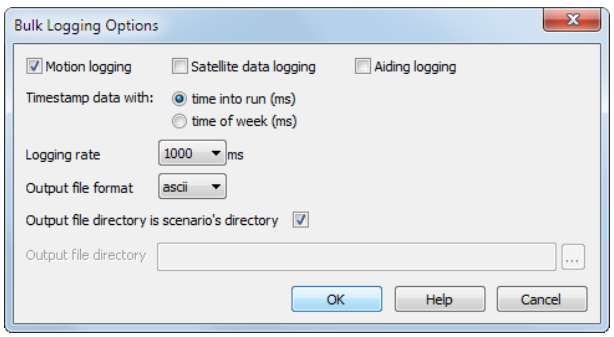
***Notes**:*

***1)** From SimGEN version 2-83 onward, you must connect a valid Spirent signal generator to the SimGEN Controller, or install a "no hardware" licence, to enable data logging to a file when you run any scenario in **No hardware ("dummy run")** mode.*

***2)** The folder for the tutorial scenario contains two log files: motion_v1.csv and sat_data_V1_A1.csv.*

SimGEN can log the data a simulation produces in the **.csv* format. This format simplifies analysis using a spreadsheet.

Click **Options-Bulk Logging Options** to open the **Bulk Logging Options** dialog:



Select **Motion Logging** and **Satellite Data Logging**.

Leave **Timestamp data** at **time into run (ms)**. Leave **Logging rate** at **1000 ms**. Leave **Output File format** as **ASCII**.

Click **OK**.

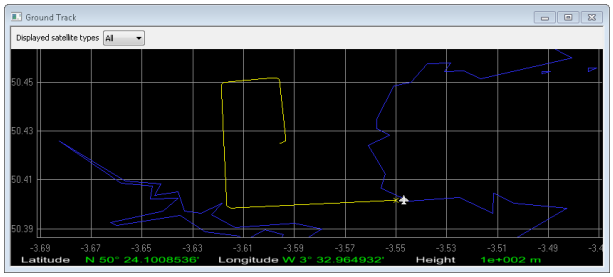
The menu item **Options-*Bulk logging options*** (page 5-1) details setting up Bulk logging.

#### 4.6.1.9 Run the new scenario

You now have a complete scenario that is ready to run using SimGEN.

Go to **File** and save the scenario as *basic*.

Run this scenario by clicking the toolbar button  . This figure shows the **Ground Track** window after running for around five minutes:




There is no need to run the scenario for longer than five minutes, so stop the scenario by clicking  on the toolbar.

### 4.6.2 Set up an advanced scenario

In the following sections, you will modify the basic scenario you created in the previous section and create an advanced scenario. This table shows the steps to follow:

| Step | Description |
|---|---|
| A | ***Remove satellite 3 from the scenario*** (page 4-29) |
| B | ***Apply a multipath signal using a User Action file*** (page 4-30) |
| C | ***Disable Tropospheric and Ionospheric delay*** (page 4-32) |
| D | ***Apply Terrain obscuration*** (page 4-32) |
| E | ***Add Pseudorange Ramp to satellite 2*** (page 4-34) |
| F | ***Use an interference source (optional)*** (page 4-35) |
| G | ***Change logging to record specific data items*** (page 4-36) |
| | ***Summary of advanced scenario*** (page 4-39) |

First, start SimGEN by double-clicking on the desktop icon. After SimGEN starts, if you cannot see the **Scenario contents** window, click on the Scenario contents button, see ***Main display windows*** (page 3-1).

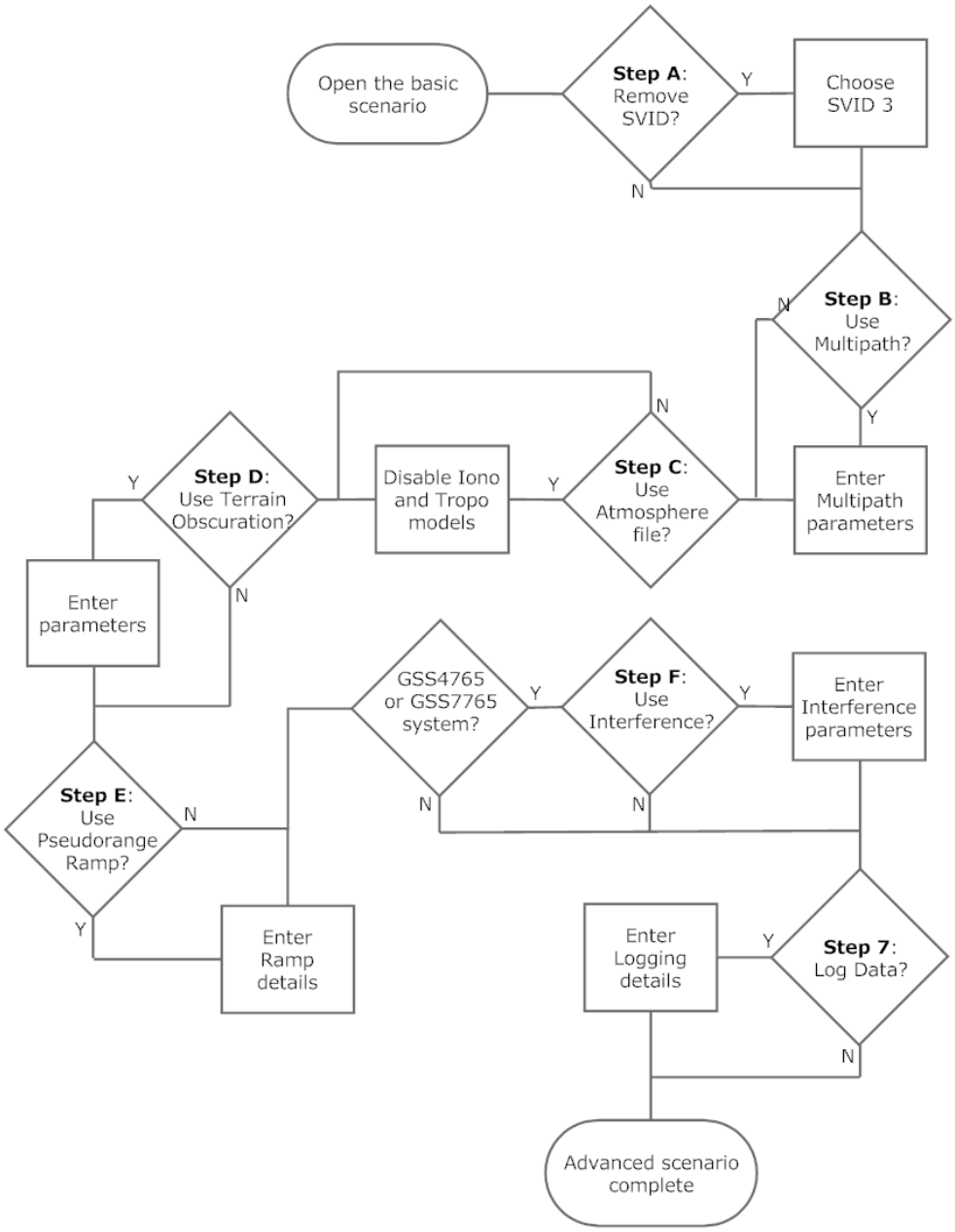
Working in the main SimGEN window, click **File-Open**.

Navigate to the location where you saved *basic.scn,* the basic scenario you created. Remember, SimGEN creates a sub-folder of the *Scenario* folder with the same name as your scenario, so you will find the basic scenario in *C:\Program Files\Spirent Communications\Positioning Application\Scenarios\basic\basic.scn.* Click **Open**.

Here is a flow chart of the process we shall follow to create the advanced scenario using the basic scenario.



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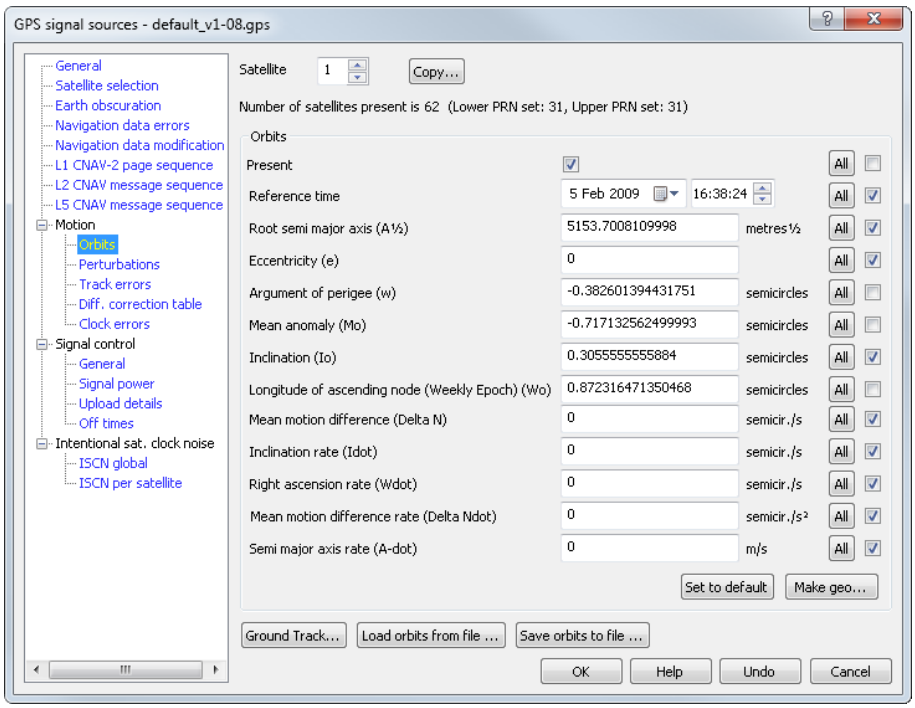



First, we will remove a satellite from the scenario.

#### 4.6.2.1 Remove satellite 3 from the scenario

In the **Scenario contents** window, expand **GPS constellation**. Open the signal sources file editor by selecting and double-clicking **GPS constellation-Signal sources file** then selecting **Motion-Orbits**:


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Use the up and down arrow buttons next to **Satellite** to select **Satellite 3** then deselect **Present**. Notice **Number of satellites present** is decreases by one.

Click **OK** and save the signal sources file with a name of your choice. We use *advanced tutorial orbits.gps*.

The scenario will now run without **Satellite 3**.

### 4.6.2.2 Apply a multipath signal using a User Action file

***Note**: You must manually build the Command file list in the order you want. SimGEN does not automatically order these actions.*

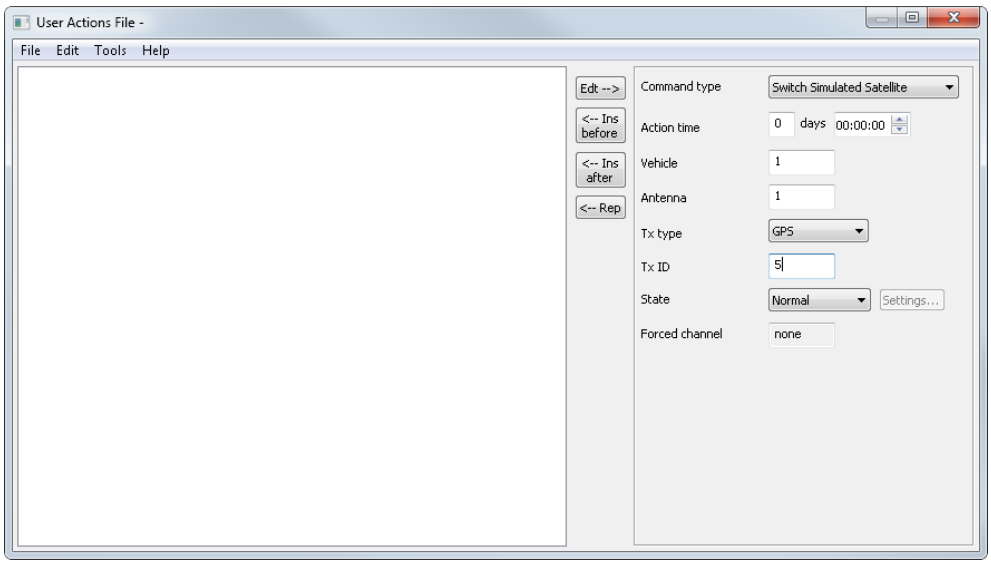
Multipath signals simulate one, or more, reflections (or echoes) of the direct signal (the Line of Sight or LoS) from the satellite to the vehicle. ***Channel assignment and multipath types*** (page 24-1) details SimGEN's multipath models. Each model lets you use different numbers of multipaths.

We need to use a User Action file to incorporate the multipath signal into the scenario. This means we will use SimGEN's ***List Editor*** (page 5-33) to create our User Action file. You may remember when we created the basic scenario, we used the List Editor to create the Aircraft command file. Although the parameters are different, you use the same methods to add multipaths to the scenario.

Notice there is no default command in the left-hand area when we create the multipath, unlike the default **Reference** command in the Aircraft motion command file.

In the **Scenario contents** window, expand **Options**. Double-click **User Actions file** to open the List Editor for the User Actions File:

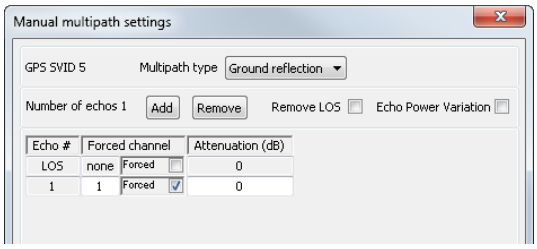

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Select **Command Type-Switch Simulated Satellite**.

Type *"19"* for the value of Tx ID (this is the SVID).

Select **State-Multipath**. The **Manual multipath settings** dialog opens automatically. If it does not, click **Settings....**




Use the default **Multipath type-Ground reflection**. Although not part of this tutorial, you may want to look at other Multipath types at this stage. Ensure you return to **Multipath type-Ground Reflection**.

Click **Add** to add a multipath signal to the LoS (Line of Sight) signal. A new row (Echo #1) appears in the table under the LOS row as shown in the figure above.

Notice **Number of echoes** increases by one.

In the new row, select **Forced.** The Forced channel defaults to channel 1 - you can enter channels from 1 to 12. Click **OK**.

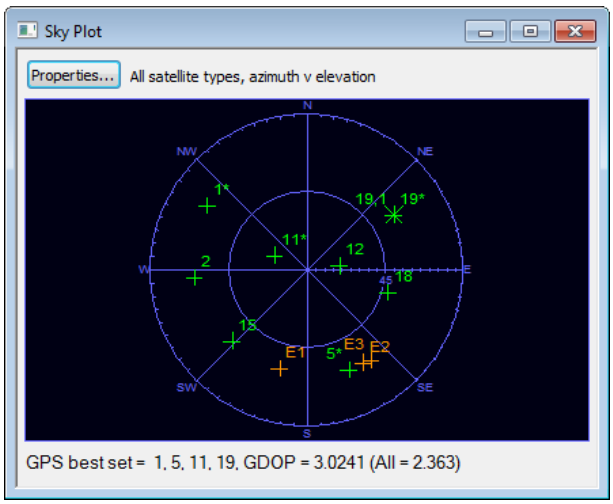
Click **Ins before** or **Ins after** to add this command to the file. Using an **Action Time** of 0 00:00:00 means SimGEN will apply the multipath as soon as the scenario starts.

Click **File-Save As** to save the User Actions file using a name of your choice. We use *advanced tutorial multipath.act*.

#### 4.6.2.3 Set Sky Plot to show multipaths

We will set the **Sky Plot** window to show multipaths as well as the Line of Sight signals:


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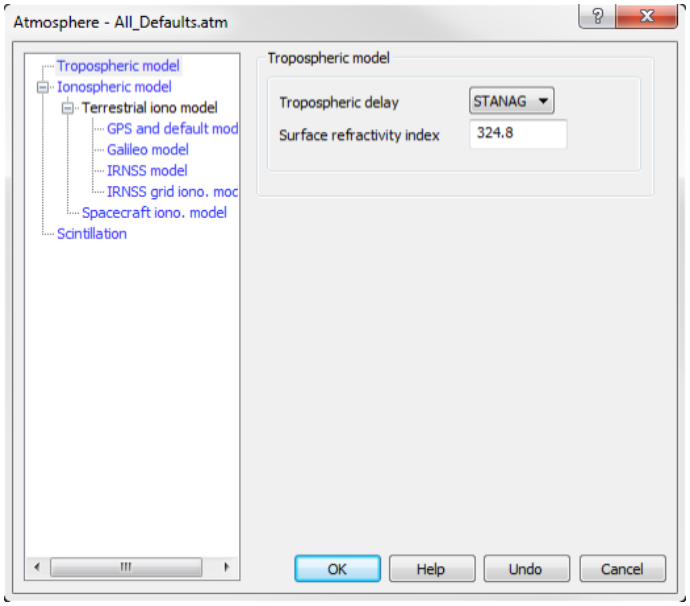

In the main SimGEN window, locate the **Sky Plot** window and click **Properties...** then select **Show multipaths**. Click **OK**.

You will see two symbols for satellite 19: a "+" labelled "19" and an "x" labelled "19,1". 19,1 is the multipath signal we set up for SVID 19.

### 4.6.2.4 Disable Tropospheric and Ionospheric delays

In this advanced scenario, we will disable the Atmospheric effects due to both the Troposphere and Ionosphere.

Move to the **Scenario contents** window and expand **Atmosphere**. Select **Atmosphere file** then double-click it to open the **Atmosphere** file editor.




Select **Tropospheric model-Tropospheric delay-Disabled** and select **Ionospheric model-Ionospheric delay models-Off**. Click **OK**. Enter a name for the modified Atmosphere file. We use *advanced tutorial.atm*.

***Atmosphere file*** (page 9-1) details modelling Ionospheric and Tropospheric delays.

### 4.6.2.5 Apply Terrain obscuration

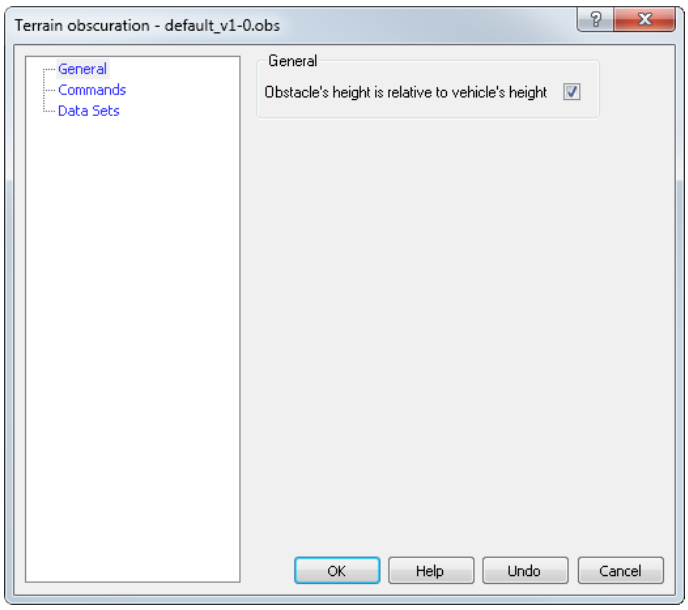
In this advanced scenario, we use terrain obscuration so that SimGEN can turn off satellite signals if they are below the modelled horizon. The terrain obscuration model provides variation in terrain and results in simulations that are more realistic for receivers in environments such as hilly areas. Without this model, SimGEN models the ground as a simple ellipsoid.

We use a mountainous environment in the advanced scenario.

**Vehicle models-*Terrain obscuration file*** (page 21-65) details adding terrain obscuration to a scenario.

Move to the **Scenario contents** window. Expand **Vehicle** then expand **Options**. Select **Terrain obscuration file** and double-click it to open the **Terrain obscuration** file editor:

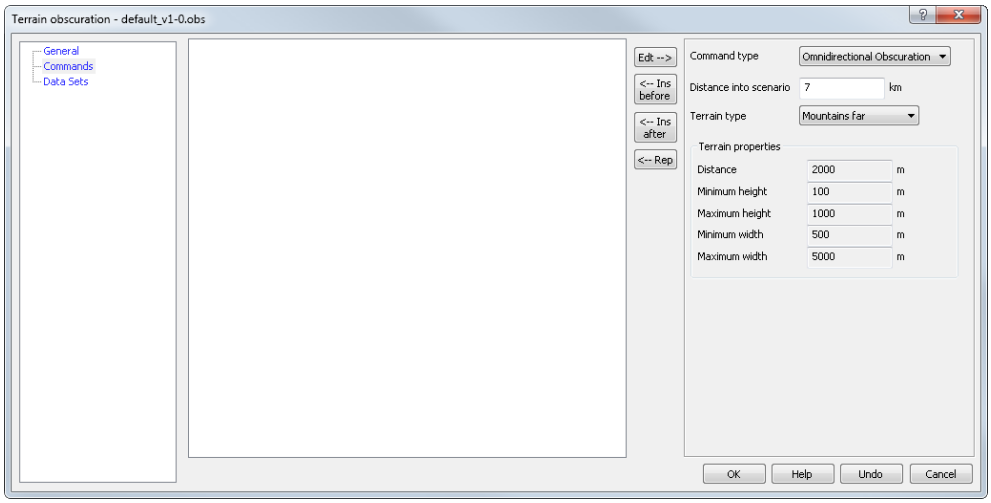

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Click **Commands**. There is only one Command type.

Notice, as before, there is no default command in the left-hand area.

Type *"7"* in **Distance into scenario** and select **Terrain type-Mountains far**, see the figure below. Notice how the other parameters in **Terrain properties** change from the defaults for **Terrain type-flat**:

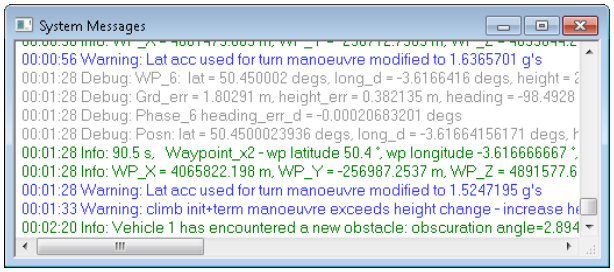



Click **Ins before** or **Ins after** to add this action to the file.

Click **OK**. Enter a name for the modified file. We use *advanced tutorial.obs*.

To use this terrain obscuration file select the file and ensure there is a tick in the checkbox to the left of the filename. The tick indicates the scenario will use this file.

Notice when the scenario runs, the **System Messages** window will report when the vehicle encounters an obstacle and the obscuration angle - see the last line in this figure:



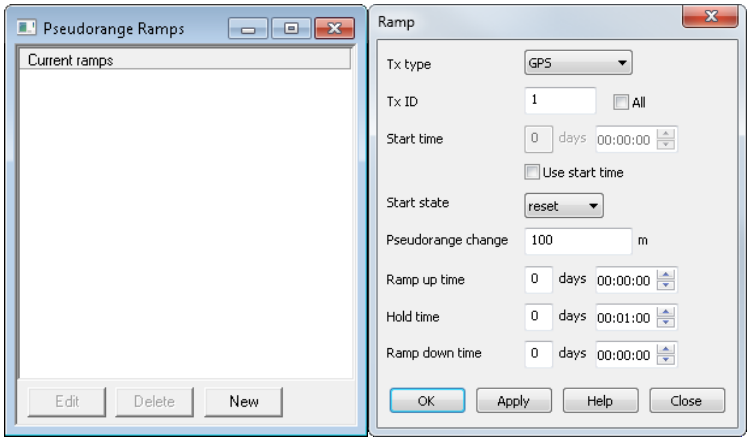


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#### 4.6.2.6 Add Pseudorange Ramp to satellite 2

**Channel assignment and multipath types-*Pseudorange ramps*** (page 24-21) details using pseudorange ramps. They provide a method to introduce controlled errors into a simulation and are equivalent to applying a pseudorange error to a satellite.

Working in the main SimGEN window open the **Pseudorange Ramps** dialog, see the figure below, by clicking the toolbar button for pseudorange ramp/step  , then Click **New** to open the Ramp dialog:




Now:

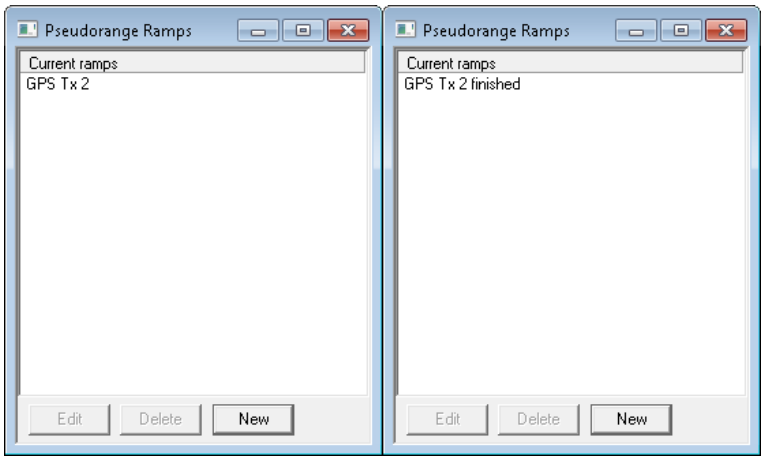
- Type "*2"* in the Tx ID text box - this is the SVID
- Select **Use start time**
- Type *"0"* days, *"00:00:10"* in the **Start time** text box
- Type *"500000"* in the **Pseudorange change** text box
- Type *"0"* days *"00:00:30"* in the **Ramp up time** text box
- Type *"0"* days *"00:00:10"* in the **Ramp down time** text box

Leave all other parameters at their default values.

Click **OK** to add this new ramp to the list of current ramps shown in the left-hand figure below.

When the Ramp has run, the dialog will show finished, see the right-hand figure below.

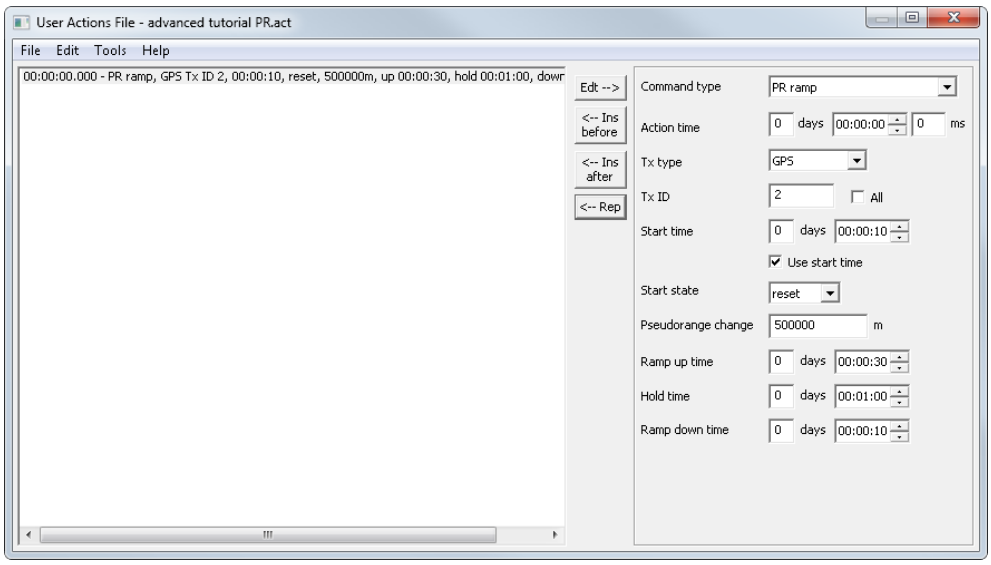
For this tutorial, do not close the **Pseudorange Ramps** dialog:




Notice you cannot save these **Pseudorange Ramp** settings. You must create the ramp each time you run this scenario.

Alternatively, if you want to re-use a specific Pseudorange ramp, define it by creating a User Action file containing **Command Type-PR ramp** (***Apply a multipath signal using a User Action file*** (page 4-30) details using User Actions files):


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The figure above shows the List Editor using the settings given at the beginning of this section.

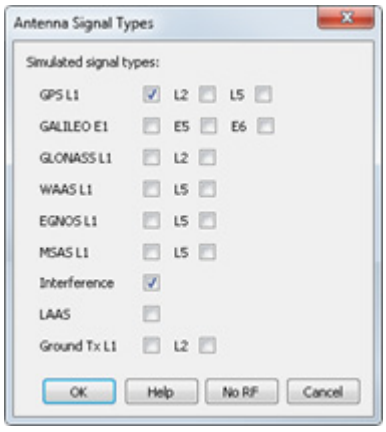
### 4.6.2.7 Use an interference source (optional)

***Note**: To use **Interference**, you must have at least one GSS7765 in your configuration, together with at least one Interference Signal Generator.*

If you do not have the correct signal generator, or you do not a valid configuration selected, you will see the flashing “Incompatible Hardware" message in the Status bar. For further information on using interference sources - see reference nn).

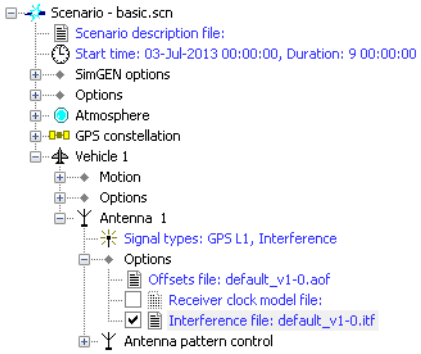
The interference source is a separate Agilent signal generator that provides an interfering signal. This interference source is under the control of SimGEN. We shall use the SimGEN ***List Editor*** (page 5-33) to set up an interfering signal that, if you had a suitable system, the signal generator will produce.

In the **Scenario Contents** window expand **Vehicle** and then expand **Antenna**. Double-click **Signal types** and select **Interference**, see this figure:

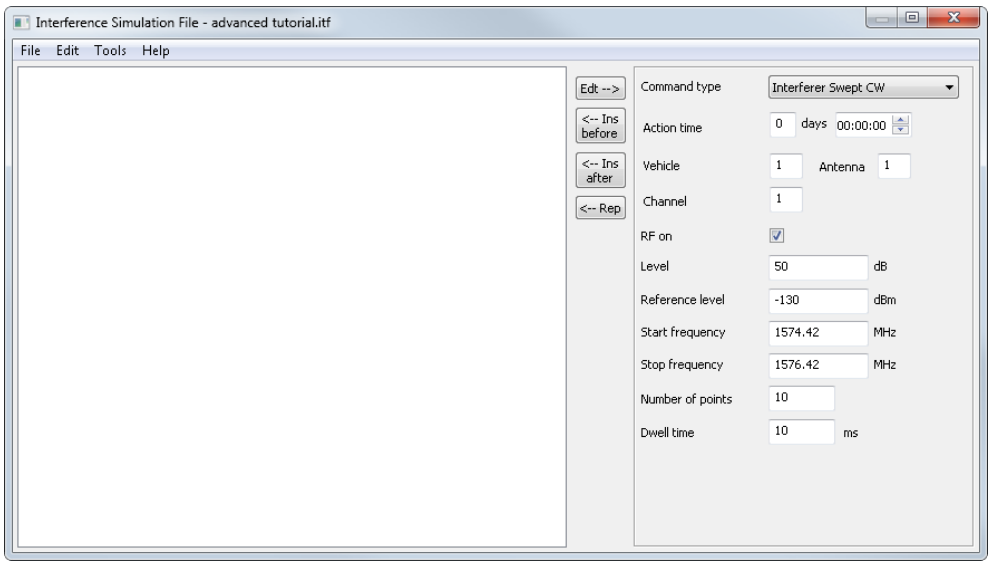



Click **OK**.

Return to the **Scenario contents** window and expand **Antenna-Options**. Select **Interference file** as below:




Double-click **Interference file** to open the **Interference Simulation File** ***List Editor***:




Select **Command type-Interferer Swept CW** and use the default settings for this command type. Click **Ins Before** or **Ins After**.

Now click **File-Save As** and enter a name for the interference file. We use *advanced tutorial.itf.*

To use this interference file select the file and ensure there is a tick in the checkbox to the left of the filename. The tick indicates the scenario will use this file.

### 4.6.2.8 Change logging to record specific data items

***Note***: *From SimGEN version 2-83 onward, you must connect a valid Spirent signal generator to the SimGEN Controller to enable data logging to a file when you run any scenario in* ***No hardware ("dummy run")*** *mode. The Menu item* ***Options-Bulk logging options*** *(page 5-1) details the sequence and style of the warning messages you will see if you do not connect a valid Spirent signal generator to the SimGEN Controller.*

For the advanced scenario, we use a different way of logging data by using logging keywords that you specify from the appropriate SimGEN keywords. First, choose a top-level keyword and then choose the keywords and any associated parameters. ***Accessing simulation (Quick-Look) data*** (page 25-1) gives more details on logging data.

→ Select the menu item **Options-Bulk Logging Options**.

→ Deselect **Motion Logging** and **Satellite Data Logging**.

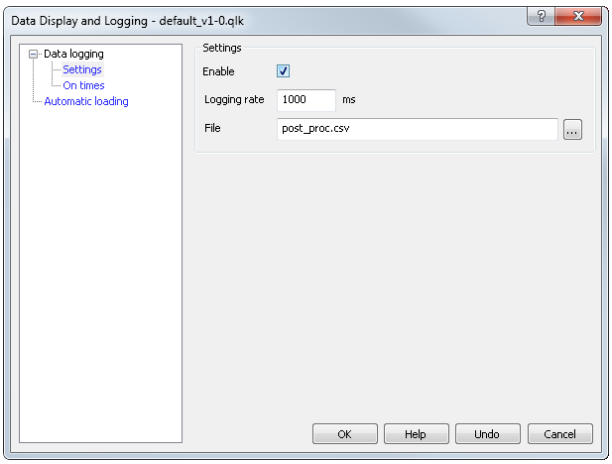
→ Click **OK**.

→ Working in the **Scenario contents** window, expand **Options** and double-click **Data display and logging file**.

→ Select **Data logging-Settings-Enable**:



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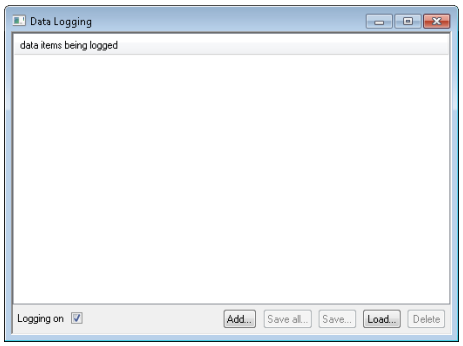



→ Click **OK**.

→ Type a name for the modified file we use *advanced tutorial.qlk*

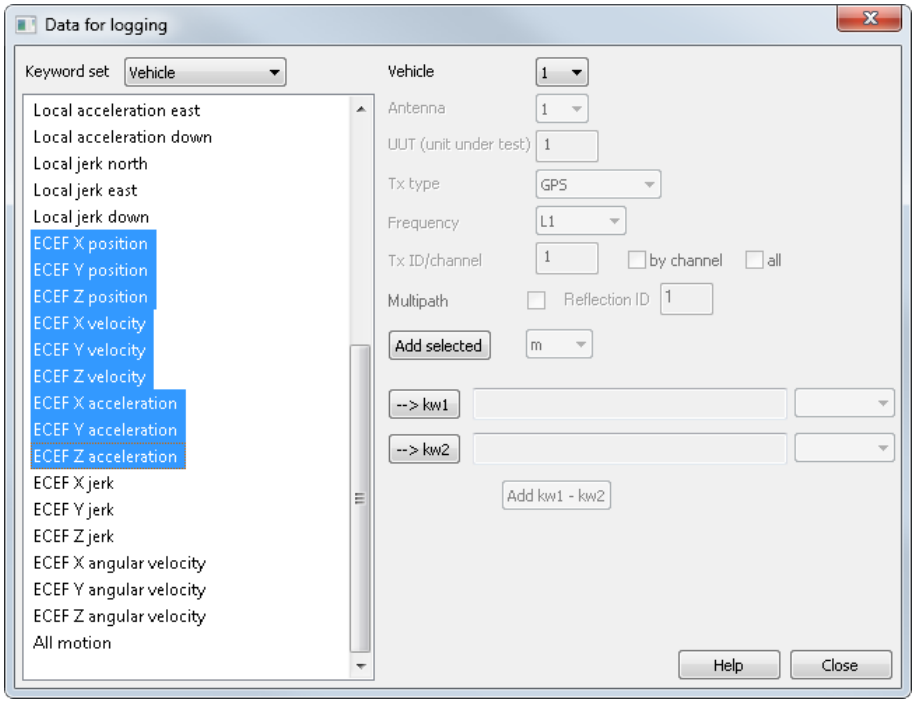
→ Click **Save**

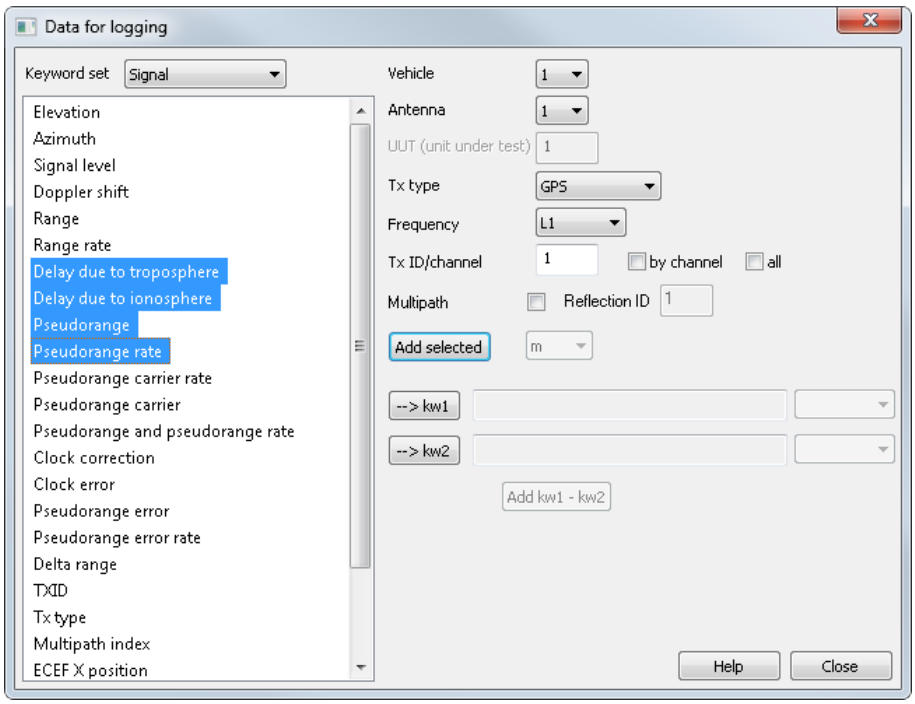
Return to the main SimGEN window and click on the toolbar button for Data logging control,  . This opens an empty **Data Logging** dialog:




→ Select **Logging on**

→ Click **Add** to open the **Data for logging** dialog:

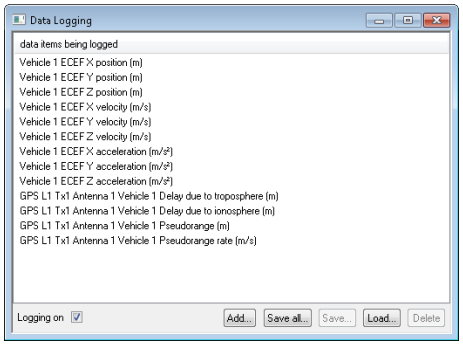





First, we will set SimGEN to log ECEF position, velocity and acceleration data for the vehicle and then log Signal delay and pseudorange data

- See the upper dialog above and select **Keyword set-Vehicle**.
- Click **ECEF X position**, press the Shift key and click **ECEF Z acceleration**. This selects all items between the items you select.
- Click **Add selected**.
- Now see the lower dialog above and select **Keyword set-Signal**.
- Select **Delay due to troposphere**, press CTRL and select **Delay due to ionosphere**, **Pseudorange** and **Pseudorange rate**. This lets you select individual items, rather than a range.
- We want to log this signal data for SVID 2, so type "*2*" in **Tx ID/channel** - this is the satellite using the pseudorange ramp we previously created.
- Click **Add selected**.
- Click **Close** to close the Data for logging window.

Your Data Logging window will look like this:




- Click **Save all…** and save the file as *advanced tutorial.qll*.
- Close the **Data Logging** window.

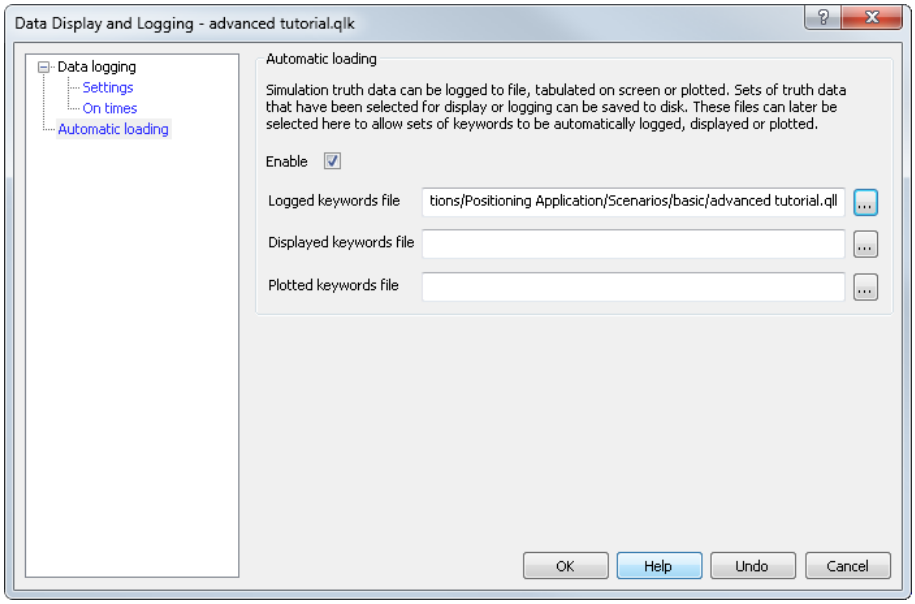
Return to the **Scenario contents** window and double-click **Options-Data display and logging file**. Select **Automatic loading-Enable**.


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Click on **...** and browse for *advanced tutorial.qll* in the **Logged Keywords File** text box.

Click **Open**.

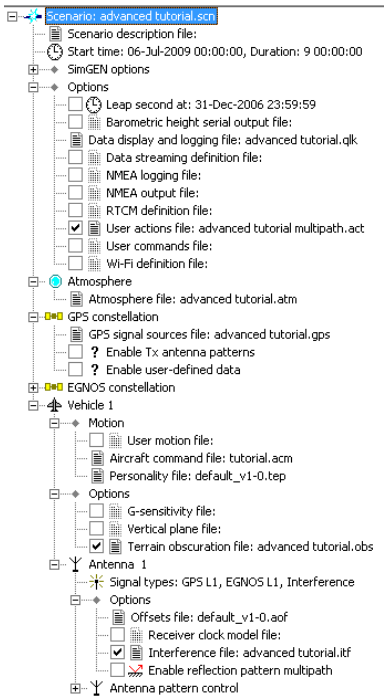
Now click **OK** to save your Data display and logging file and save the file. We use the name *advanced tutorial.qlk*:




Finally, return to the main SimGEN window and click **File-Save** to save the changes you have made to a scenario name of your choice. We use *advanced tutorial.scn*.

### 4.6.2.9 Summary of advanced scenario

The figure below shows the expanded **Scenario contents** window with all items that we have changed for the advanced scenario. Unchanged items (such as EGNOS constellation and antenna pattern control) remain collapsed.




### 4.6.2.10 Running the advanced scenario

***Note***: *From SimGEN version 2-83 onward, you must connect a valid Spirent signal generator to the SimGEN Controller, or install a "no hardware" licence, to enable data logging to a file when you run any scenario in* ***No hardware ("dummy run")*** *mode.*

You now have a complete scenario that is ready to run using SimGEN.

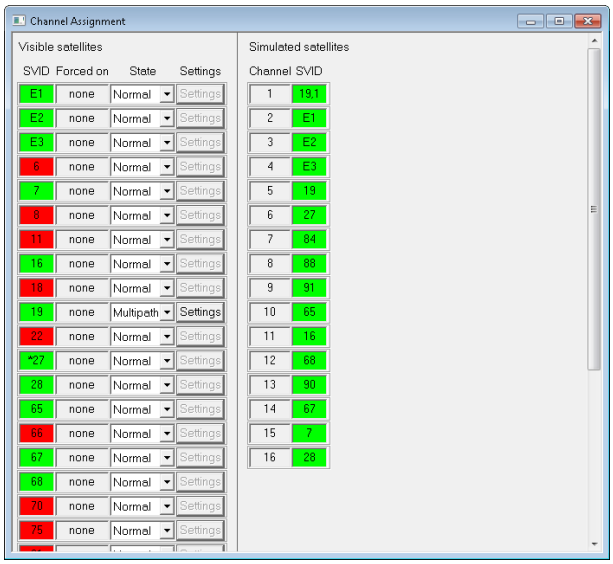

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To run the scenario, first ensure *Scenario: advanced scenario.scn* appears at the top of the **Scenario contents** window. If it does not, click **File-Open** and search for the scenario file *advanced tutorial.scn* in the *advanced tutorial* folder.

Run this scenario by clicking the toolbar **Run** button,  . In creating the advanced scenario, we have not made changes to the vehicle or its motion. While running the advanced scenario you will see the same ground track as the basic scenario you created earlier in ***Set up a basic scenario*** (page 4-19).

Notice the status bar, at the bottom of the main **SimGEN** window. It uses the flashing text “LOG” on a green background, to show Logging is taking place during the scenario.

While the scenario is running click on the toolbar **Channel assignment** button,  to open the **Channel Assignment** dialog:




The **Visible satellites** area shows SVID 19 is in **State-Multipath**. In the **Simulated satellite** area, you can see **Channel 1** as **SVID 19,1**, where channel 19,1 is the first-order reflection multipath signal from satellite 19.

There is no need to run the scenario for longer, click the **Stop** toolbar button,  .

After you have stopped the scenario, open the file *post_proc.csv* in the scenario folder. This file contains the logged data for the keywords you specified in the *advanced scenario.qll* file. Use Excel to open this file and:

→ Verify the Ionospheric delay and Tropospheric delay fields are zero throughout the scenario.

→ Verify application of the pseudorange ramp for TxID 2 (this is SVID 2) by looking at the last column in *post_proc.csv*.

You should see a jump in the pseudorange rate at around 10 seconds, when the ramp to the new pseudorange starts and at around 40 seconds when this ramp finishes.


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# 5 Menus

This Chapter details SimGEN specific Menu items. It does not describe standard Windows Menu items.

## 5.1 File

***Note**: You can use **File-Save As** to save a scenario under a new name and to a new folder, letting you export scenarios. **Save As** copies all required shared files to a new, shared, folder, in a location you select.*

**New**, **Open**, **Close** and **Save**, apply to the whole scenario (a hierarchical set of files).

Printing prints highlighted source files as ASCII text.

The most recently used scenarios are shown (**.scn* files).

Spirent recommends using the Toolbar buttons instead of **File-Run**, **Fast Forward** and so on.

### 5.1.1 Enter SimREPLAY mode

## 5.2 View

Use the View menu to display or hide SimGEN's Toolbars and windows. You can also use the SimGEN toolbar buttons to display certain windows

## 5.3 Options

The following table shows the items in the **Options** menu:

| Options menu |
|---|
| ***Bulk logging options*** |
| ***Control Options*** (page 5-13) |
| ***General Options*** (page 5-15) |
| ***Hardware Configuration*** (page 5-25) |
| ***IEEE Usage*** (page 5-26) |
| ***Message Reporting*** (page 5-26) |
| ***Remote Command Settings*** (page 5-28) |
| ***RS-232 port settings*** (page 5-28) |
| ***User Actions Recording*** (page 5-30) |

Notice that:

- → Options you set using the ***Options*** menu apply to all scenarios you run with SimGEN
- → Options you set using the ***Options*** menu will be overwritten by options you set using <**scenario name**>**-SimGEN options**

### 5.3.1 Bulk logging options

***Notes**:*

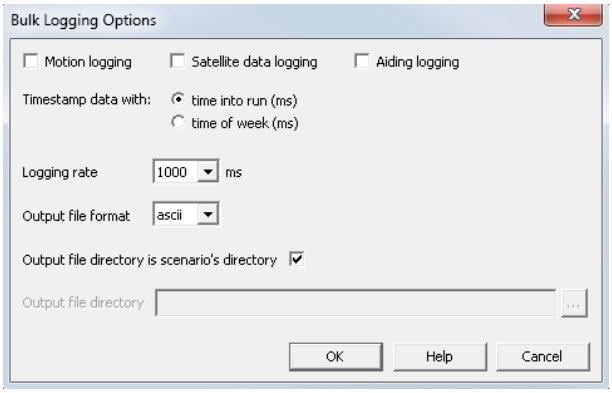
***1)** From SimGEN version 2-83 onward, you must connect a valid Spirent signal generator to the SimGEN Controller, or install a "no hardware" licence, to enable data logging to a file when you run any scenario in **No hardware ("dummy run")** mode.*

***2)** You must enable **Vehicle-Aiding** (page 22-1) to record aiding bulk logging data. When you run the scenario, the **System Messages** window shows a Warning if you have select **Aiding logging** without enabling the **INS model file**.*

***3)** C50r SimGEN Host users see **Important details for all users of the C50r SimGEN Host** (page 1-8)*


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You can log most simulation data to a file. Spirent recommends you use bulk logging, which is more efficient in terms of processing time. The figure below shows the **Bulk Logging Options dialog**.

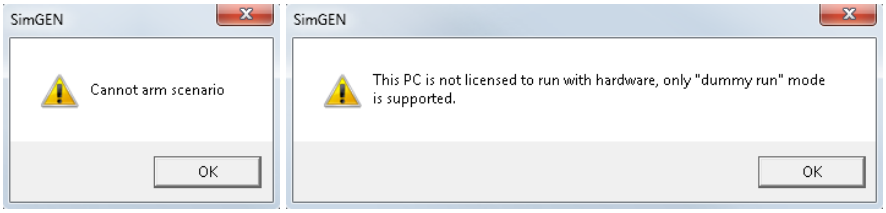



| | |
|---|---|
| **(Logging type)** | Select the logging you want to record:<br>Aiding logging (see Note 2) above), and/or<br>Motion logging, and/or<br>Satellite data logging (satellite data logging includes signal data) |
| **Timestamp data with:** | Choose one of the following: |
| **time into run (ms)** | (default) Timestamps the data with the time into run in seconds, resolution in milliseconds |
| **time of week (ms)** | Timestamps the data with the 'real' time of week. This is the initial time of week at the start of the scenario plus the time into run, in seconds, resolution in milliseconds.<br>This replaces the time into run parameter in the aiding, motion and satellite data logging files. |
| **Logging rate** | The logging rate must be an integer multiple of the Simulation Iteration Rate, the Menu item ***General Options*** (page 5-15) details setting the Simulation Iteration Rate.<br>Choose a value from the drop-down list. |
| **Output file format** | Choose one of the following: |
| **ASCII** | (default) - a comma-separated variable (**.csv*) file you can import into a spreadsheet or maths package.<br>Some parameters are only available in ASCII mode; these parameters are marked explicitly in the parameter description. |
| **Binary** | Binary is an efficient storage format<br>You can record data at 10 milliseconds intervals and save around 25% disk space compared to ASCII.<br>You must decode Binary files using **SimGEN Utilities-*Binary to ASCII file conversion utility*** (page 26-61) |
| **Output file directory is scenario's directory** | Select (default): writes the output file to the scenario folder<br>Deselect: writes the output file to the folder you specify in **Output file directory** |

You can log most simulation data to a file. Spirent recommends you use bulk logging, which is more efficient in terms of processing time. However, if you only want to log a few items, see ***Accessing simulation (Quick-Look) data*** (page 25-1).

If you enable any of the **Bulk logging** options (or any other "logging to a file" option) and attempt to run the scenario without connecting a valid Spirent signal generator to the SimGEN Controller, SimGEN will not arm the scenario. This is the sequence of error messages:


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#### 5.3.1.1 ASCII output file descriptions

***Note**: The header of each Aiding, Motion and Satellite Data bulk logging file contains the start time of the scenario (in integer seconds from GPS time zero).*

SimGEN splits the logged data into three groups:

- ***Aiding data***
- ***Motion data***
- ***Satellite data***

The output files are located in the relevant scenario folder.

There will be one aiding file and one motion file for each vehicle. These files are *aiding_V"n".csv* and *motion_V"n".csv*, respectively, where "n" is the vehicle number.

There will be one satellite data file for each vehicle, for each antenna. These files are *sat_data_V"n"A"m".csv*, where "n" is the number of the vehicle and "m" is the number of the antenna.

Each file has the following, comma delimited, with this format:

- A header line that describes general properties of the file
- A line describing each column
- A list of each record

***Vehicle models*** (page 21-1) details body axes and attitudes that SimGEN's vehicle models use.

##### 5.3.1.1.1 Aiding data

***Note**: Aiding data position is relative to the position of the aiding sensor, which may not be the same as the CofG of the vehicle.*

SimGEN logs aiding data when you select **Vehicle-Aiding-INS Model file**, which means you will select one of the aiding models. SimGEN only produces Aiding UDP data when you select **SimINERTIAL**, **SimEGI** or **Inertial IMU**. If you select bulk logging, SimGEN always logs aiding data.

The header line has the following elements:

- File build standard
- Vehicle type
- Log interval (milliseconds)
- Scenario start time (in integer seconds from GPS time zero)

Aiding data parameters:

| Parameter Group | Description (units) |
|---|---|
| Time_ms | Time to which the data relates (milliseconds) |
| Pos_X,<br>Pos_Y,<br>Pos_Z | Position with respect to ECEF frame, in ECEF axes<br>(m) |


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| Parameter Group | Description (units) |
|---|---|
| Vel_X,<br>Vel_Y,<br>Vel_Z | Velocity with respect to ECEF frame, in ECEF axes<br>($m.s^{-1}$) |
| Acc_X,<br>Acc_Y,<br>Acc_Z | Acceleration with respect to ECEF frame, in ECEF axes<br>($m.s^{-2}$) |
| Jerk_X,<br>Jerk_Y,<br>Jerk_Z | Jerk with respect to ECEF frame, in ECEF axes<br>($m.s^{-3}$) |
| Lat,<br>Long,<br>Height | Latitude (radians), Longitude (radians) and Height (metres)<br>with respect to the WGS84 ellipsoid |
| Vel_N,<br>Vel_E,<br>Vel_D | Velocity with respect to ECEF frame, in Local Geodetic co-ordinates<br>North (radians), East (radians), Down (metres) |
| Vel_Bx,<br>Vel_By,<br>Vel_Bz | Velocity with respect to ECI frame, in body axes co-ordinate<br>($m.s^{-1}$) |
| Acc_Bx,<br>Acc_By,<br>Acc_Bz | Acceleration with respect to ECI frame, in body axes co-ordinates<br>($m.s^{-2}$) |
| Jerk_Bx,<br>Jerk_By,<br>Jerk_Bz | Jerk with respect to ECI frame, in body axes co-ordinate<br>($m.s^{-3}$) |
| Heading,<br>Elevation,<br>Bank | Heading, elevation and bank, in Local Geodetic co-ordinates<br>(all radians) |
| Ang-vel_X,<br>Ang-vel_Y,<br>Ang-vel_Z | Angular velocity with respect to ECEF frame, as rotation about the body axes<br>($rad.\ s^{-1}$) |
| Ang-acc_X,<br>Ang-acc_Y,<br>Ang-acc_Z | Angular acceleration with respect to ECEF frame, as rotation about the body axes<br>($rad.s^{-2}$) |
| Ang-jerk_X,<br>Ang-jerk_Y,<br>Ang-jerk_Z | Angular jerk with respect to ECEF frame, as rotation about the body axes<br>($rad.s^{-3}$) |
| Ang-jerk-rate_X,<br>Ang-jerk-rate_Y,<br>Ang-jerk-rate_Z | Angular jerk rate with respect to ECEF frame, as rotation about the body axes<br>($rad.s^{-4}$) |
| Ang-vel-I_X,<br>Ang-vel-I_Y,<br>Ang-vel-I_Z | Angular velocity with respect to ECI frame, as rotation about the body axes<br>($rad.s^{-1}$) |
| Ang-acc-I_X,<br>Ang-acc-I_Y,<br>Ang-acc-I_Z | Angular acceleration with respect to ECI frame, as rotation about the body axes<br>($rad.s^{-2}$) |
| Ang-jerk-I_X,<br>Ang-jerk-I_Y,<br>Ang-jerk-I_Z | Angular jerk with respect to ECI frame, as rotation about the body axes<br>($rad.s^{-3}$) |
| Ang-jerk-rate-I_X,<br>Ang-jerk-rate-I_Y,<br>Ang-jerk-rate-I_Z | Angular jerk rate with respect to the ECI frame, as rotation about the body axes<br>($rad.s^{-4}$) |


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| Parameter Group | Description (units) |
|---|---|
| Acc-aid-I-I_X,<br>Acc-aid-I-I_Y,<br>Acc-aid-I-I_Z | Linear acceleration with respect to ECI frame, in ECI co-ordinates<br>($m.s^{-2}$) |
| Jerk-aid-I-I_X,<br>Jerk-aid-I-I_Y,<br>Jerk-aid-I-I_Z | Linear jerk with respect to ECI frame, in ECI co-ordinates<br>($m.s^{-3}$) |

Aiding Record List

There is one record for each time stamp for each column in the column description section.

#### 5.3.1.1.2 Motion data

***Note**: The motion data position is relative to the vehicle CofG, while the antenna parameters are relative to the antenna position.*
*These two positions may not be the same.*

The header line has the following elements:

- File build standard
- Vehicle type
- Logging interval in ms
- Number of antennas
- DOP Type (text, one of GDOP, PDOP, HDOP, VDOP or TDOP)
- Scenario start time (in integer seconds from GPS time zero)

ASCII format motion data parameters:

| Parameter Group | Description (units) |
|---|---|
| Time_ms | Time to which the data relates (milliseconds) |
| Pos_X,<br>Pos_Y,<br>Pos_Z | Position with respect to ECEF frame, in ECEF axes<br>(metres) |
| Vel_X,<br>Vel_Y,<br>Vel_Z | Velocity with respect to ECEF frame, in ECEF axes<br>($m.s^{-1}$) |
| Acc_X,<br>Acc_Y,<br>Acc_Z | Acceleration with respect to ECEF frame, in ECEF axes<br>($m.s^{-2}$) |
| Jerk_X,<br>Jerk_Y,<br>Jerk_Z | Jerk with respect to ECEF frame, in ECEF axes<br>($m.s^{-3}$) |
| Lat,<br>Long,<br>Height | Latitude (radians), Longitude (radians) and Height (metres)<br>with respect to the WGS84 ellipsoid |
| Heading,<br>Elevation,<br>Bank | Heading, elevation and bank, in Local Geodetic co-ordinates<br>North (radians), East (radians), Down (metres) |
| Ang-vel_X,<br>Ang-vel_Y,<br>Ang-vel_Z | Angular velocity with respect to ECEF frame, as rotation about the body axes<br>($rad.s^{-1}$) |


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| Parameter Group | Description (units) |
|---|---|
| Ang-acc_X,<br>Ang-acc_Y,<br>Ang-acc_Z | Angular acceleration with respect to ECEF frame, as rotation about the body axes<br>(rad.s-$^{2}$) |
| Ant1_Pos_X,<br>Ant1_Pos_Y,<br>Ant1_Pos_Z, | Position of Antenna 1 with respect to ECEF frame, in ECEF axes<br>(metres) |
| Ant1_Vel_X,<br>Ant1_Vel_Y,<br>Ant1_Vel_Z, | Velocity of Antenna 1 with respect to ECEF frame, in ECEF axes<br>(m.s$^{-1}$) |
| Ant1_Acc_X,<br>Ant1_Acc_Y,<br>Ant1_Acc_Z, | Acceleration of Antenna 1 with respect to ECEF frame, in ECEF axes<br>(m.s-$^{2}$) |
| Ant1_Lat,<br>Ant1_Long,<br>Ant1_Height, | The Latitude (radians), Longitude (radians) and Height (metres) of Antenna 1, with respect to the WGS84 ellipsoid |
| Ant1_DOP | The DOP value |
| Orb Head,<br>Orb Elev,<br>Orb Bank | The orbital attitude with respect to the orbital plane, given as Heading, elevation, bank (all radians)<br>This parameter is only available in ASCII logging.<br>This parameter only appears in the case of spacecraft |

Motion Record List

There is one record for each time stamp for each column in the column description section.

#### 5.3.1.1.3 Satellite data

The header line has the following elements:

- File build standard
- Scenario start time in GPS seconds
- Logging interval in milliseconds
- Number of channels available for this antenna

ASCII format satellite data:

| Parameter Group | Description (units) |
|---|---|
| Time_ms | Time to which the data relates (milliseconds) |
| Channel | Satellite channel |
| Sat_type | Satellite type, see the table below |
| Sat_ID | Satellite ID |
| Sat_PRN | Satellite PRN |
| Echo_Num | (If multipath is in use) path number of the multipath.<br>Path 0 is the direct path |
| Sat_Pos_X,<br>Sat_Pos_Y,<br>Sat_Pos_Z | ECEF position of satellite at transmit time of the signal, in ECEF axes at the time of reception (m) , where time of reception is Time_ms, given above |
| ***Note**: Bulk logged ASCII data Sat_Pos_X, Sat_Pos_Y and Sat_Pos_Z, contain the same data as **Quick Look-Signal** keywords ECEF X position, ECEF Y position and ECEF Z, see **Quick look - Signal** (page 25-6)* | |


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| Parameter Group | Description (units) |
|---|---|
| Sat_Vel_X,<br>Sat_Vel_Y,<br>Sat_Vel_Z | ECEF velocity of satellite at transmit time of the signal, in ECEF axes at the time of reception ($m.s^{-1}$) where time of reception is Time_ms, given above |
| Azimuth | Azimuth arrival angle of the satellite signal, in Local Geodetic co-ordinates (radians) |
| Elevation | Elevation arrival angle of the satellite signal, in Local Geodetic co-ordinates (radians) |
| Range | Satellite range<br>(metres) |
| P-Range L1CA,<br>P-Range L2P,<br>P-Range L5 | Pseudorange<br>(metres) |
| P-R_rate | Pseudorange rate only for L1, even if you have not selected L1 (see ***Associate a GNSS signal with an antenna*** (page 23-4))<br>($m.s^{-1}$) |

***Notes**:*

***1)** The satellite data file shows constellation types separately.*

***2)** GPS satellites will always report **P-R_rate** based on the GPS L1 frequency,*
*GLONASS satellites will always report **P-R_rate** based on the GLONASS L1 frequency, and so on.*

***3)** To calculate **P-R_rate** for any other frequency, use the equation: pseudorange_rate = (-Doppler) * λ*

*Where:*

*i) The bulk logging file gives values for Doppler for each signal frequency*

*ii) λ is the wavelength of the signal frequency you want to use*

| | |
|---|---|
| Iono_delay L1CA,<br>Iono_delay L2P,<br>Iono_delay L5,<br>Tropo_delay | Ionospheric and Tropospheric delays<br>(seconds) |
| P-R_Error | The error on the Pseudo Range due to errors including: Delta AF clock errors, Clock noise, PR noise (remote commands), PR ramp, SA effects |
| Signal_dB L1CA,<br>Signal_dB L2P,<br>Signal_dB L5 | Signal level<br>(dB) |
| Ant_azimuth | Azimuth arrival angle of the signal with respect to the antenna level pattern (radians) |
| Ant_elevation | Elevation arrival angle of the signal with respect to the antenna level pattern (radians) |
| Range_rate | True range rate<br>($m.s^{-1}$) |
| P-R_Error_rate | Rate of change of the error in the simulated signal delay<br>($m.s^{-1}$) |
| Doppler_shift L1 | Doppler offset applied to L1 carrier<br>(Hz) |
| Doppler_shift L2/E5 | L2/E5 Doppler offset<br>(Hz)<br>Derived from the L2/E5 pseudorange rate offset, which is set to the L1 pseudorange rate offset ($m.s^{-1}$) in SimGEN<br>Use:<br>Quick Look keywords to log Doppler for any constellation and frequency your scenario uses<br>then use the formula pseudorange_rate= (-Doppler) x λ |


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| Parameter Group | Description (units) |
|---|---|
| Doppler_shift L5/E6 | L5/E6 Doppler offset<br>(Hz) Derived from the L5/E6 pseudorange rate offset, which is set to the L1 pseudorange rate offset ($m.s^{-1}$) in SimGEN |
| Delta_range L1 | Change in satellite range over a time interval, plus the change in the satellite clock (and receiver clock, if simulated) over the same time interval.<br>This is divided by the time interval to give units of $m.s^{-1}$ |
| Delta_range L2/E5 | Redundant field |
| Delta_range L5/E6 | Redundant field |
| Sat_Acc_X,<br>Sat_Acc_Y,<br>Sat_Acc_Z | ECEF acceleration of satellite at transmit time of the signal, in ECEF axes at the time of reception<br>(metres) where time of reception is Time_ms, given above |

| Constellation | Sat_type | Constellation | Sat_type |
|---|---|---|---|
| GPS | 0 | LAAS | 8 |
| WAAS | 1 | GALILEO | 9 |
| EGNOS | 2 | Ground Transmitter | 10 |
| MSAS | 3 | Quasi-Zenith | 11 |
| GLONASS | 4 | IRNSS | 23 |
| Interferer | 5 | BeiDou | 24 |
| Base Station | 6 | CAPS | 25 |
| GSM | 7 | | |

Satellite Record List

There is one record for each time stamp for each column in the column description section.

#### 5.3.1.2 Binary output file descriptions

***Note**: SimGEN saves this binary data in little-endian format.*

SimGEN splits the logged data into three groups:

- → ***Aiding data***
- → ***Motion data***
- → ***Satellite data***

The header of each Aiding, Motion and Satellite Data bulk logging file contains the start time of the scenario (in integer seconds from GPS time zero).

The output files are located in the relevant scenario folder.

There will be one aiding file and one motion file for each vehicle. These files are *aiding_V"n".bin* and *motion_V"n".bin,* respectively, where "n" is the vehicle number.

There will be one satellite data file for each vehicle, for each antenna. These files are *sat_data_V"n"A"m".bin*, where "n" is the number of the vehicle and "m" is the number of the antenna.


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This table details the data formats:

| Data format | Number of Bytes used |
|---|---|
| signed int | 4 |
| double | 8 |
| double*3 | three groups of 8 |
| float | 4 |

### 5.3.1.2.1 Aiding data

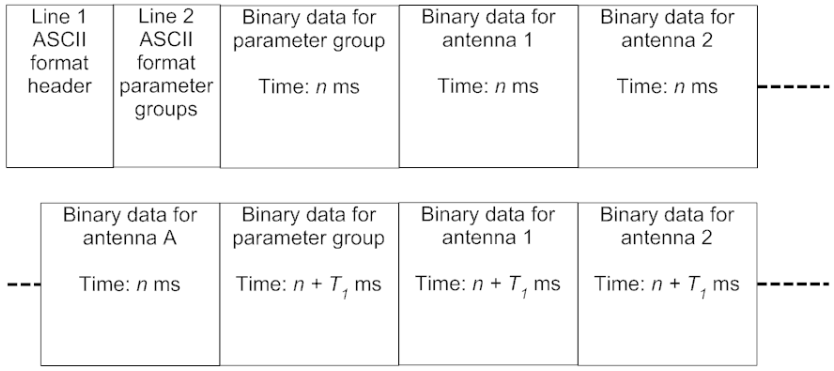
***Note**: Aiding data position is relative to the position of the aiding sensor, which may not be the same as the CofG of the vehicle.*

Aiding data is present when you select aiding data and the vehicle INS model.

The aiding data file records aiding motion at each of the logging rate time steps, T in the figure below.

The first line contains a comma-separated, ASCII string header, containing:

- File build standard
- Vehicle type
- Logging interval in milliseconds
- Scenario start time (in integer seconds from GPS time zero)




The second line contains a comma-separated, list of parameter groups. The first column of this table shows the parameter groups.

| Parameter Group (units) | Data format |
|---|---|
| Time-into-run (milliseconds) | signed int |
| ECEF position (metres for x, y, z) | double*3 |
| ECEF velocity ($m.s^{-1}$ for x,y,z) | double*3 |
| ECEF acceleration ($m.s^{-2}$ for x,y,z) | double*3 |
| ECEF jerk ($m.s^{-3}$ for x,y,z) | double*3 |
| WGS84 ellipsoid latitude (radians) | double |
| WGS84 ellipsoid longitude (radians) | double |
| WGS84 ellipsoid height (metres) | double |
| Velocity with respect to ECEF frame, expressed in Local Geodetic components North, (radians); East, (radians); Down, (metres) | double*3 |


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| Parameter Group (units) | Data format |
|---|---|
| Velocity with respect to ECEF frame, in body-axis co-ordinates ($m.s^{-1}$) | double*3 |
| Acceleration with respect to ECEF frame, in body-axis co-ordinates ($m.s^{-2}$) | double*3 |
| Jerk with respect to ECEF frame, in body-axis co-ordinates ($m.s^{-3}$) | double*3 |
| Heading in Local Geodetic components (radians) | double |
| Elevation in Local Geodetic components (radians) | double |
| Bank in Local Geodetic components (radians) | double |
| Angular velocity with respect to ECEF frame, as rotation about the body axes ($rad.s^{-1}$) | double*3 |
| Angular acceleration with respect to ECEF frame, as rotation about the body axes ($rad.s^{-2}$) | double*3 |
| Angular jerk with respect to ECEF frame, as rotation about the body axes ($rad.s^{-3}$) | double*3 |
| Angular jerk rate with respect to ECEF frame, as rotation about the body axes ($rad.s^{-4}$) | double*3 |
| Angular velocity with respect to ECI frame, as rotation about the body axes ($rad.s^{-1}$) | double*3 |
| Angular acceleration with respect to ECI frame, as rotation about the body axes ($rad.s^{-2}$) | double*3 |
| Angular jerk with respect to ECI frame, as rotation about the body axes ($rad.s^{-3}$) | double*3 |
| Angular jerk rate with respect to ECI frame, as rotation about the body axes ($rad.s^{-4}$) | double*3 |
| Linear acceleration rate with respect to the ECI frame, in ECI co-ordinates ($m.s^{-2}$) | double*3 |
| Linear acceleration rate with respect to the ECI frame, in ECI co-ordinates ($m.s^{-3}$) | double*3 |

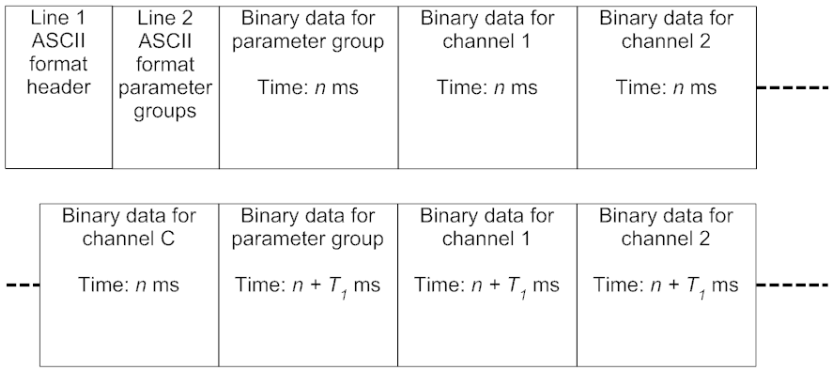
The rest of the file contains binary-formatted data for each parameter group, repeated at each logging rate time step.

#### 5.3.1.2.2 Motion data

***Note**: The motion data position is relative to the vehicle CofG, while the antenna parameters are relative to the antenna position.*
*These two positions may not be the same.*

This file records aiding motion at the Simulation Iteration Rate (the rate SimGEN calculates and updates data, see ***General Options*** (page 5-15)), T in this figure:


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The first line contains a comma-separated, ASCII string header, containing:

- File build standard
- Vehicle type
- Logging interval (ms)
- Number of antennas (A in the figure above)
- DOP Type (text, one of GDOP, PDOP, HDOP, VDOP or TDOP)
- Scenario start time (in integer seconds from GPS time zero)

The second line contains a comma-separated, ASCII list of parameter groups. The first column in the table below shows the parameter groups and the binary-formatted data of each parameter group, followed by the binary-formatted data for each antenna attached to the vehicle (as described in the first header line parameter “Number of antennas”) in the next table. The file then repeats for the next logging rate time step as in the figure above.

| Parameter Group | Data format |
|---|---|
| Time-into-run, milliseconds | signed int |
| ECEF position (metres for x, y, z) | double*3 |
| ECEF velocity ($m.s^{-1}$ for x, y, z) | double*3 |
| ECEF acceleration ( $m.s^{-2}$ for x, y, z) | double*3 |
| ECEF jerk ($m.s^{-3}$ for x, y, z) | double*3 |
| WGS84 ellipsoid latitude (radians) | double |
| WGS84 ellipsoid longitude (radians) | double |
| WGS84 ellipsoid height (metres) | double |
| Vehicle heading, elevation and bank (radians for all) | double*3 |
| Angular velocity with respect to ECEF frame expressed as rotation about the body axes ($rad.s^{-1}$) | double*3 |
| Angular acceleration with respect to ECEF frame expressed as rotation about the body axes, ($rad.s^{-2}$) | double*3 |

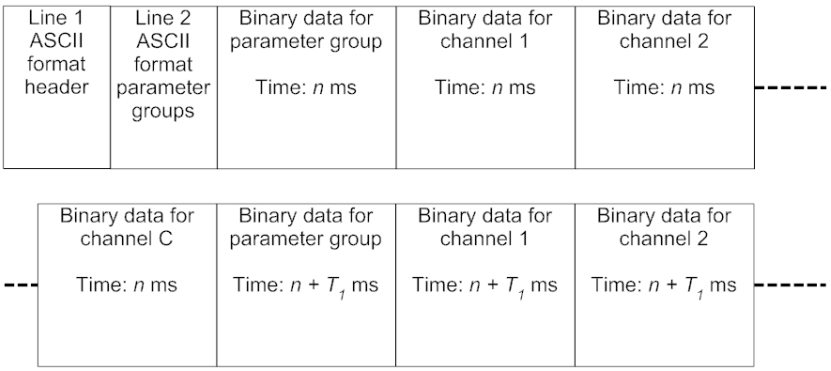
| Parameter Group (units) | Data format |
|---|---|
| Position of antenna with respect to ECEF frame (metres for x, y, z) | double*3 |
| Velocity of antenna with respect to ECEF frame ($m.s^{-1}$ for x,y,z) | double*3 |
| Acceleration of antenna with respect to ECEF frame ($m.s^{-2}$ for x,y,z) | double*3 |


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| Parameter Group (units) | Data format |
|---|---|
| WGS84 ellipsoid latitude of antenna (radians) | double |
| WGS84 ellipsoid longitude of antenna (radians) | double |
| WGS84 ellipsoid height of antenna (metres) | double |
| DOP | float |

### 5.3.1.2.3 Satellite data

This file records aiding motion at the Simulation Iteration Rate (the rate SimGEN calculates and updates data, set in ***General Options*** (page 5-15), T in the figure below.




The first line contains a comma-separated, ASCII string header, containing:

- File build standard
- Scenario start time (GPS seconds)
- Logging interval in milliseconds
- Number of channels available for this antenna (C in the figure below)

The second line contains a comma-separated, ASCII list of parameter groups. The first column of the following two tables shows the parameter groups and the binary-formatted data of the parameter group, see the first table below; followed by the binary-formatted data for each channel (as described in the first header line parameter “Number of channels”) see the next table. The file then repeats for the next logging rate time step as in the figure above.

| Parameter Group (units) | Data format |
|---|---|
| ***Note**: Bulk logged, binary-formatted data for ECEF position (x, y and z co-ordinates), contains the same data as **Quick look - Signal** (page 25-6) keywords ECEF X position, ECEF Y position and ECEF Z position* | |
| Time-into-run (milliseconds) | signed int |
| Number of channels | signed int |
| ECEF velocity ($m.s^{-1}$ for x,y,z) | double*3 |
| Satellite range (metres) | double |
| Pseudorange L1CA (metres) | double |
| Pseudorange L2P (metres) | double |
| Pseudorange L5 (metres) | double |
| Pseudorange rate ($m.s^{-1}$) | double |
| Range error (metres) | double |
| Azimuth arrival angle of satellite, in Local Geodetic frame (radians) | float |



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| Parameter Group (units) | Data format |
|---|---|
| Elevation arrival angle of satellite, in Local Geodetic frame (radians) | float |
| Ionospheric delay L1CA (seconds) | float |
| Ionospheric delay L2P (seconds) | float |
| Ionospheric delay L5 (seconds) | float |
| Tropospheric delay (seconds) | float |
| Signal level L1CA (dB) | float |
| Signal level L2P (dB) | float |
| Signal level L5 (dB) | float |
| Azimuth arrival angle of the signal, with respect to the antenna level pattern (radians) | float |
| Elevation arrival angle of the signal, with respect to the antenna level pattern (radians) | float |
| Channel number | signed int |
| Satellite type | signed int |
| Satellite SVID | signed int |
| PRN | signed int |
| Multipath index | signed int |
| Range rate ($m.s^{-1}$) | double |
| Range error rate ($m.s^{-1}$) | double |
| Doppler shift L1 (Hz) | double |
| Doppler shift L2/E5 (Hz) | double |
| Doppler shift L5/E6 (Hz) | double |
| Delta range ($m.s^{-1}$) | double |
| Delta range ($m.s^{-1}$ - redundant) | double |
| Delta range ($m.s^{-1}$ - redundant) | double |
| ECEF acceleration ($m.s^{-2}$ for x,y,z) | double*3 |

### 5.3.2 Control Options

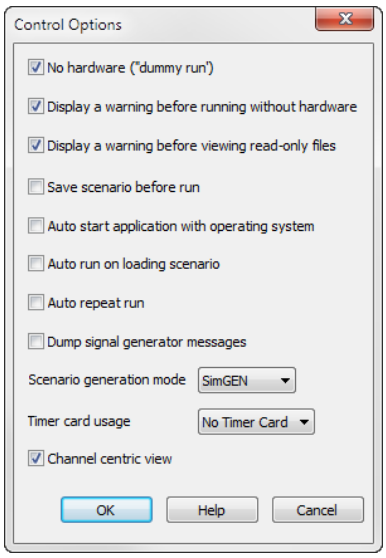
***Notes:***

***1)*** *In all cases, the H/W field on the status display changes from green to amber in* ***No hardware*** *mode.*

***2)*** *ULTS users - be aware* ***PLTS and ULTS - NovAtel message emulation*** *(page 5-23) has an additional item.*

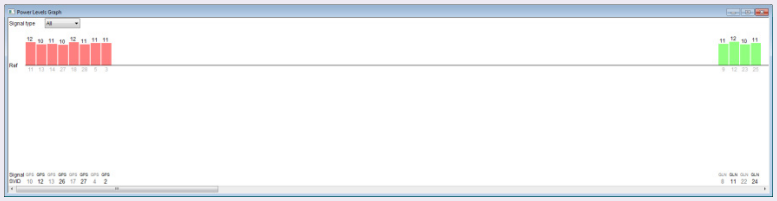
This figure shows the **Control Options** menu:


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| | |
|---|---|
| **No hardware ("dummy run")** | Select: run a scenario without connecting a signal generator.<br>You can use any Simulation Iteration Rate, see the Menu item ***General Options*** (page 5-15). |
| ***Note**: From SimGEN version 2-83 onward, you must connect a valid Spirent signal generator to the SimGEN Controller, or install a "no hardware" licence, to enable data logging to a file when you run any scenario in **No hardware ("dummy run")** mode.* | |
| **Display a warning before running without hardware** | Select: display a warning before running without a signal generator |
| **Display a warning before viewing read-only files** | Select: show the read-only warning message used in SimREPLAY and SimREPLAYplus. |
| **Save scenario before run** | Select: automatically saves scenario (if you have made changes) after you click **Run** |
| **Auto start application with operating system** | Select: automatically starts SimGEN after Windows loads |
| **Auto run on loading scenario** | Select: automatically starts running scenario 1 in the **File** menu 'Most Recently Used' list. If this list is empty, SimGEN runs the default scenario *Example1.scn*. |
| **Auto repeat run** | Select: continuously re-winds and repeats the scenario |
| ***Note**: Selecting **Autostart application with operating system** and **Autorun on loading scenario** loads SimGEN and automatically runs a scenario after you switch on the SimGEN Controller.* | |
| **Dump signal generator messages** | Only for use by Spirent Global Support Engineers. |
| **Scenario generation mode** | Choose the type of scenario SimGEN creates from **SimGEN**, **SimPLEX** or **SimREPLAY** |
| **Timer card usage** | Select from:<br>**No Timer Card**: GSS9000-series and GSS7000 signal generators (the C50r SimGEN Host and GSS7000 Embedded Host do not use a Timer Card)<br>**4ms SIR**: Only use with GSS8000-series, and earlier, signal generators when using four milliseconds Simulation Iteration Rate.<br>The Menu item ***General Options*** (page 5-15) details setting Simulation Iteration Rate.<br>**All SIR**: Use with GSS8000-series, and earlier, signal generators. |


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| | |
|---|---|
| ***Notes for GSS8000-series, and earlier, signal generators:***<br>***1)*** *You must connect the timer card to your signal generator before starting a scenario*<br>***2)*** *SimGEN ignores your* ***Timer card usage*** *selection if you use an incompatible signal generator (such as a GSS6700)* | |
| **Channel centric view** | Deselect (default): relevant windows show satellite groupings.<br>Does not show empty channels, resulting in a compact window when using a large number of channels. For example, **Power level graph**:<br>  <br>Select: relevant windows show channel groupings (legacy setting).<br>Shows empty SVIDs resulting in an extended window when using large numbers of channels; for example, the same **Power Level graph** as above:<br>  |

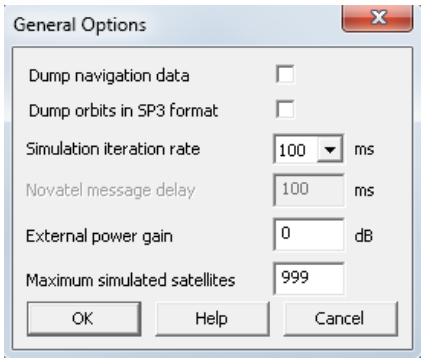
## 5.3.3 General Options

***Notes****:*

***1)*** *From SimGEN v2.70, Spirent supplies the SimGEN Controller fitted with a timer card (for systems with GSS7xxx variant B series generators). This card supports 4 milliseconds Simulation Iteration Rate. Contact Spirent for details on upgrading existing systems.*
***2)*** *For GSS8000-series, and earlier, signal generators, RF signal fidelity is identical, whether the iteration rate is 10 or 100 milliseconds and there is no advantage in using a faster iteration rate when you use internal vehicle motion models.*
*However, when you configure SimGEN for remote trajectory operation the choice of signal generator update-rate DOES affect signal fidelity. This is especially true where the simulated remote vehicle is executing high-dynamic manoeuvres. Reference qq) gives details on this topic.*

***3)*** *C50r SimGEN Host users see* ***Important details for all users of the C50r SimGEN Host*** *(page 1-8)*

This figure shows the **General Options** menu:



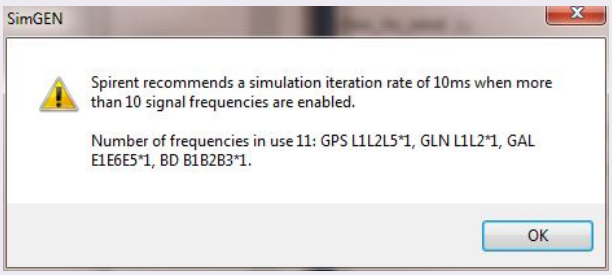


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| | |
|---|---|
| **Dump navigation data** | ***Note**: C50r SimGEN Host users see **Important details for all users of the C50r SimGEN Host** (page 1-8)*<br><br>Deselect (default): does not write navigation data to a file<br>Select: writes all navigation data bits for the currently simulated signal types to a binary or ASCII dump file. SimGEN writes these 'dump' files to the current working folder, usually the folder of the currently selected scenario.<br>Use one of the ***SimGEN utilities*** (page 26-1) to convert this data to a readable format. |
| **Dump orbits in SP3 format** | ***Note**: C50r SimGEN Host users see **Important details for all users of the C50r SimGEN Host** (page 1-8)*<br><br>Deselect (default): does not write orbital data using the SP3 format<br>Select: writes orbital data using the SP3 format<br><br>Currently, SimGEN supports writing orbital data in the SP3 format for all constellations in a scenario. These files use the following constellation identifiers from reference z):<br>GPS (G), GLONASS (R), Galileo (E), BeiDou (C) and QZ (J).<br>http://cddis.gsfc.nasa.gov/sp3c_satlist.html defines all supported identifiers.<br>SimGEN uses the identifier 'U' for constellations other than those defined above. |
| **Simulation iteration rate** | The rate SimGEN iterates its motion models and pseudorange calculations and which advances in discrete time steps.<br>Spirent specifies this rate as a time in milliseconds with "every" being implied.<br><br>You can set SimGEN to iterate its motion models and pseudorange calculations at any rate supported by the signal generator:<br>GSS9000-series and the C50r SimGEN Host support upt to one millisecond.<br>The major factors that determine the maximum Simulation Iteration Rate are the C50r SimGEN Host (or SimGEN Controller) specification and the number of vehicles / antennas in your scenario.<br>GSS7000 signal generators support 10 milliseconds or 100 milliseconds.<br>All GSS8000-series signal generator (using a SimGEN Controller) support a maximum rate of 10 milliseconds. However, some of these signal generators can support 4 milliseconds, see the table below: (notice Spirent supplied some SimGEN Controllers that did not support 4 milliseconds). |

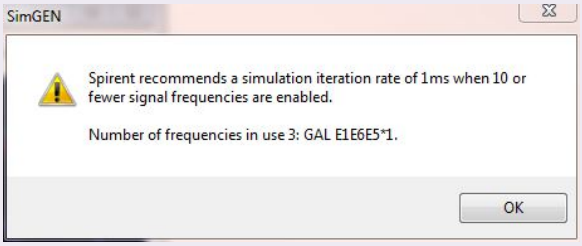

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***Note for users of two, or more, GSS9000-series signal generators**: When operating at 1 millisecond Simulation Iteration Rate, there is a limit to the number of constellations and frequencies you can use in your scenario. After you click **Run**, SimGEN checks your scenario and hardware configuration and displays this window if your scenario is affected:*




*Click **OK** to continue running your scenario, in which case it may experience stability issues.*
*If you see this window, Spirent recommends you click **OK**, then stop your scenario and change to using 10 milliseconds Simulation Iteration Rate.*

***Note for all GSS9000-series signal generator users**: Spirent recommends you always run at the highest Simulation Iteration Rate possible. After you click **Run**, SimGEN checks your scenario and hardware configuration and displays this window if you can use a higher Simulation Iteration Rate:*




*Click **OK** to continue running the scenario, in which case your simulated signal fidelity may be compromised.*
*If you see this window, Spirent recommends you click **OK**, then stop your scenario and change to using 1 millisecond Simulation Iteration Rate.*

| Signal generator | Supported Simulation Iteration Rates, milliseconds |
|---|---|
| **Current:** | |
| GSS9000-series | 1 millisecond and up |
| GSS7000 | 10 and 100 |
| GSS8000-series | 4, 10, 100 |
| GSS7xxx | 10, 100 |
| GSS7xxx (variant B) | 4, 10, 100 |
| GSS6700 | 10, 100 |
| ***Note for users of the GSS6700**: The GSS6700 supports 10 milliseconds Simulation Iteration Rate, but you cannot use 10 milliseconds Simulation Iteration Rate AND the Galileo constellation in combination with any other constellation(s).* | |
| **Superseded:** | |
| GSS6560 | 10, 100 |
| GSS5060 | 10, 20, 40, 50, 100 |
| STR4760/90 | 10, 100 |
| STR4780 | 100 |


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| | |
|---|---|
| **NovAtel message delay** | Only available with ULTS, this parameter simulates real-world transmission delay, where messages are transmitted slightly after the time to which the data in the messages relates. |
| **External Power Gain** | Type a gain or attenuation value to let SimGEN reference the actual RF power delivered to the GNSS receiver under test.<br>Resolution: 1 decimal place<br>Default : 0 dB<br><br>For example: by default, SimGEN displays signal generator power at the front panel connector relative to the Stanag minimum level of -130 dBm for GPS L1 C/A code.<br>You have a high-sensitivity receiver designed to operate at around -150 dBm and connect it to the signal generator front panel connector using a 20 dB attenuator. By setting **External Power Gain** to -20.0 dB SimGEN will display signal levels referenced to -150 dBm. |
| ***Note**: Currently, SimGEN does not check the range of the value you enter.* | |
| **Maximum simulated satellites** | Default: 999<br>Use to limit the maximum number of satellites SimGEN simulates.<br>This provides a quick way to simulate one satellite |

## 5.3.4 Hardware Configuration

***Notes**:*

***1)** **Change Hardware Configuration** (page 5-35) describes assigning additional signal generators to a scenario and configuring the scenario to use them.*

***2)** You can run the scenario in **No hardware** mode see the Menu item **Control Options** (page 5-13), in this mode SimGEN generates and logs data.*

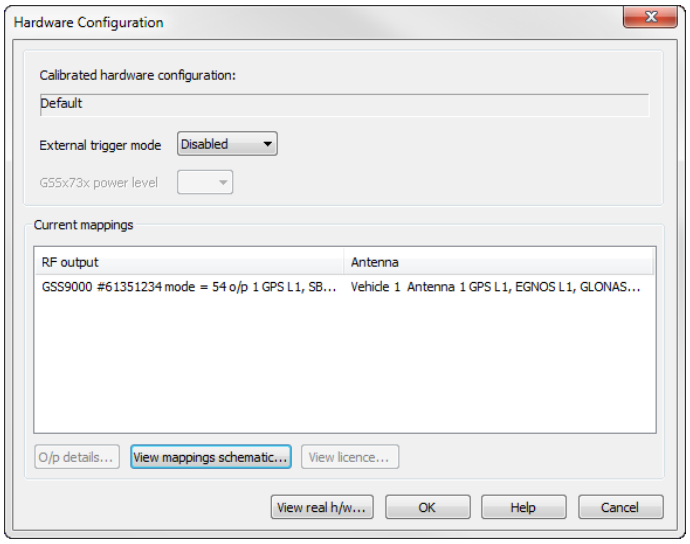
***3) View mappings schematic…** shows a schematic of the interconnections your simulator uses and does not represent physical connections.*

The signal generator you assign in your scenario must match the signal generator you are using with SimGEN. The Menu item **Tools-*Change Hardware Configuration*** (page 5-18) details changing your hardware configuration to match your signal generator.

When you create a scenario, it can define multiple vehicles and/or multiple antennas; but if you assign a signal generator whose configuration is not compatible with your scenario settings, you will see the message “Could not map every antenna to a signal output” in the ***System Messages*** window (page 3-15).

### 5.3.4.1 GSS9000-series and GSS7000 signal generators

To check your signal generator configuration, open the menu item **Options-Hardware Configuration** to display the **Hardware Configuration** window:

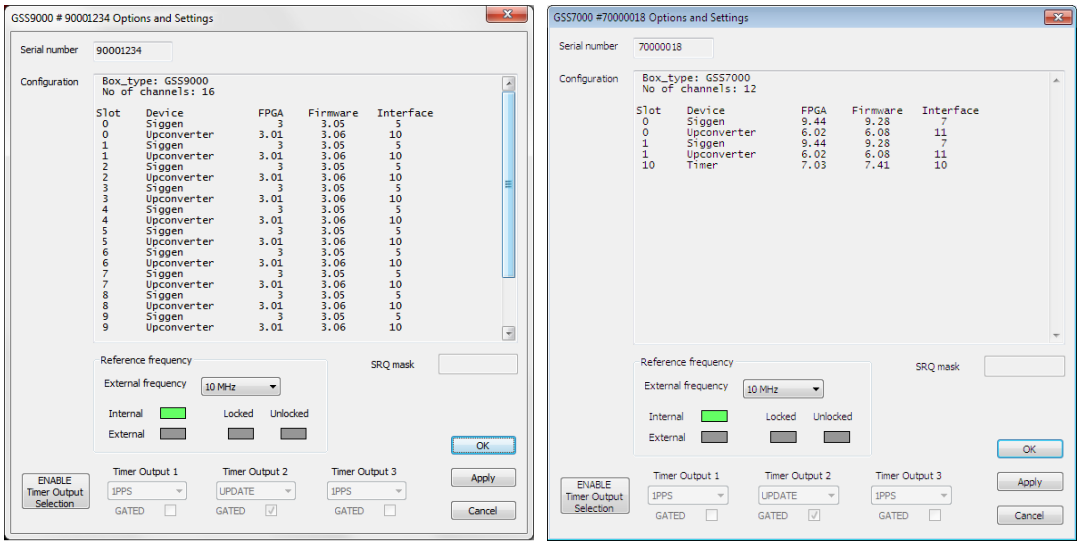




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Select a signal generator and click **View real h/w...** to see the signal generators connected to your C50r SimGEN Host or GSS7000 Embedded Host.

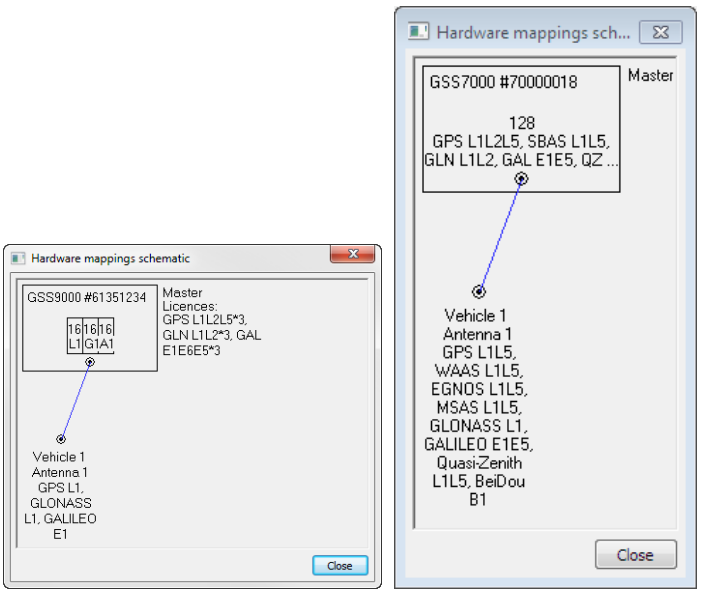
Selecting a signal generator in the **Current mappings** area enables **O/p details…**, which shows the signal generator **Options and Settings** dialog (the signal generator serial number appears in the title bar), for example:

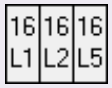



| | |
|---|---|
| **Serial number** | The serial number of your signal generator |
| **Configuration** | Shows the number of channels your signal generator supports, FPGA and Firmware details of each signal generator module and RF Upconverter module in each channel bank - see reference sss), and FPGA and Firmware details of the Timer and Reference oscillator modules |
| **Reference frequency** | Select an **External frequency** your signal generator supports - see reference sss).<br>The Reference frequency area shows the status of the frequency reference. The green indicator shows the internal reference is in use.<br>Indicators will show the phase locked status of any external reference you use. |
| **ENABLE Timer Output Selection** | Normally the **Timer Outputs** are disabled to prevent accidental changes.<br><br>Click to enable each **Timer Output** setting and choose the timer output you want to use for each of **Timer Output 1**, **Timer Output 2** and **Timer Output 3**.<br>Select from:<br>**1PPS** Rising edge synchronised with one second epochs in simulated GPS time<br>**100PPS** Rising edge synchronised with 1PPS at start of scenario and maintained throughout the scenario<br>**UPDATE** Up to Timer FPGA version 5.00 this setting provides a 1 kHz pulse<br>From Timer FPGA 5.00 onwards, this setting provides a pulse at the Simulation Iteration Rate, see ***General Options*** (page 5-15)<br>All velocity changes occur on the rising edge of the pulse<br>**HIGH** Output is permanently high<br>**TPOP** User-defined update pulse for use by SimINERTIAL<br><br>You can also select each timer output to be **GATED** (timer output is present only when a scenario is running)<br><br>Reference sss) gives more detail on the **Timer Outputs**<br>SimGEN applies the new settings when you click **OK** or **Apply** |

Click **View mappings schematic…** to see a schematic of the mapping between your signal generator and the vehicle and antenna characteristics of the current scenario. This figure shows typical mapping for a single-output GSS9000-series signal generator:


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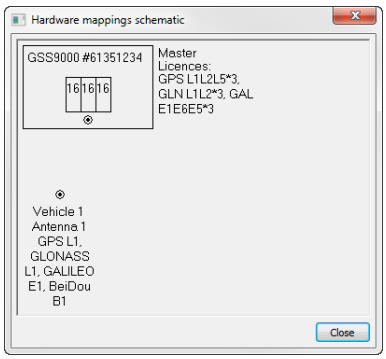

| | |
|---|---|
| In the left-hand figure above, the box represents the GSS9000-series signal generator and shows its serial number.<br>In the right-hand figure, the box represents the GSS7000 signal generator and shows its serial number. | |
|  | In the left-hand figure, each rectangle shows the number of channel banks installed in the GSS9000-series signal generator and the frequency it is generating.<br>This example shows three channel banks<br>The figure inside each rectangle shows the number of channels for that channel bank,<br>this example shows 16 for each of three channel banks<br>The letter/number combination below the number of channels is the generated frequency, using the ***Sky Plot*** (page 3-4) constellation identifiers (except in this dialog GPS uses the prefix 'L')<br><br>The right-hand figure shows the number of licenced channesl and the licenced constellations. |
| Master<br>Licences:<br>GPS L1L2L5*3,<br>GLN L1L2*3, GAL<br>E1E6E5*3 | Identifies the status of the signal generator (Master or Auxiliary) and the available licences.<br>For this signal generator:<br>GPS L1L2L5*3 - three licences.<br>The three channel banks can support any combination of GPS L1, L2 and L5.<br>GLN L1L2*3 - three licences.<br>The three channel banks can support any combination of GLONASS L1 and L2.<br>GAL E1E6E653 - three licences.<br>The three channel banks can support any combination of Galileo E1, E5 and E6 |
| Vehicle 1<br>Antenna 1<br>GPS L1,<br>GLONASS<br>L1, GALILEO<br>E1 | Identifies the frequencies associated with each Vehicle and Antenna<br>This example shows the frequencies associated with Vehicle 1 / Antenna 1 |

In the above figures, the line from the upper box to Vehicle / Antenna shows the signal generator supporting the constellations and frequencies the scenario defines (the Hardware is "mapped" to that Vehicle and Antenna).

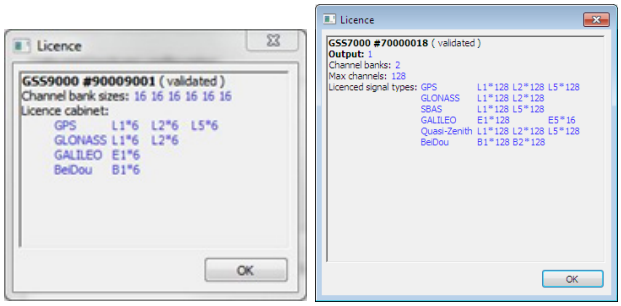
Similar links are shown for other Vehicle / Antenna combinations your scenario defines (as long as your signal generator supports these constellations and frequencies).

If your signal generator does not support the constellations your scenario uses, the linking line is missing. For example, this figure shows a GSS9000-series single-output signal generator with BeiDou B1 added to Vehicle 1 / Antenna 1 in the scenario. The signal generator in this figure does not have a BeiDou licence, so the Hardware cannot map BeiDou to Vehicle 1 / Antenna 1 and the linking line is missing:


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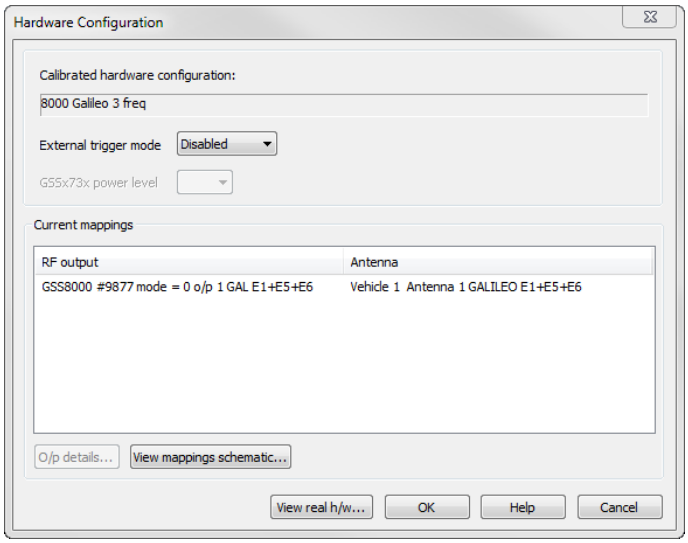

Click **Hardware Configuration-View licence…** to show the **Licence** window (each licence sets up the channel bank(s) to generate a single frequency for a specific constellation. SimGEN stores your licences in a “cabinet”), for example:




| | |
|---|---|
| **validated** | Refers to whether SimGEN has read details from an installed licence or from the *sig_gen.txt* file.<br>For SimGEN to read details from an installed licence, you must have installed a licence file and connected the relevant GSS9000-series signal generator to the C50r SimGEN Host.<br>The **Licence** window displays the constellations and frequencies you can use.<br><br>If the **Licence** window does not show validated, SimGEN has read the details of your GSS9000-series signal generator form the *sig_gen.txt* file. This will give you the ability to run only in “no hardware” mode, see ***Control Options*-No hardware (“dummy run”)** (page 5-13) |

### 5.3.4.2 GSS8000-series and earlier signal generators

To check your signal generator configuration, open the menu item **Options-Hardware Configuration** to display the **Hardware Configuration** window:




Click **View real h/w...** to see the signal generators connected to your SimGEN Controller using IEEE-488, I/P or USB interfaces.

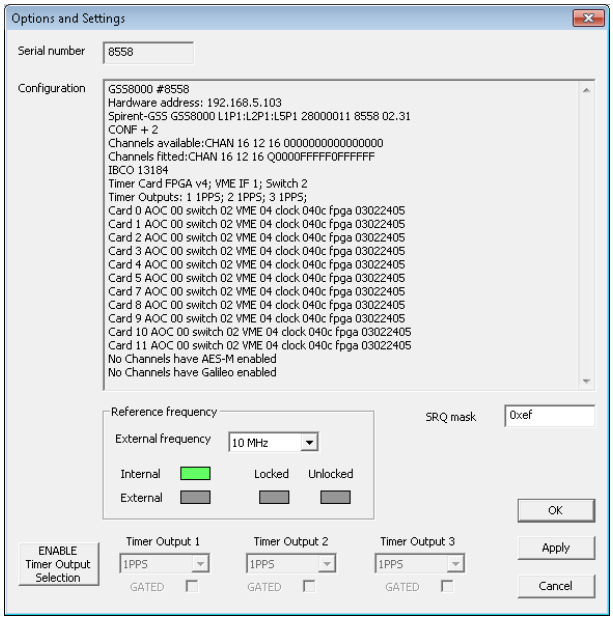
Selecting a signal generator in the **RF output** area enables **O/p details…** which shows the signal generator **Options and Settings** dialog, for example:

***Notes for the Options and Settings dialog:***

***1) ENABLE Timer Output Selection*** *is only present for GSS8000, GSS77xx or STR47xx signal generators.*

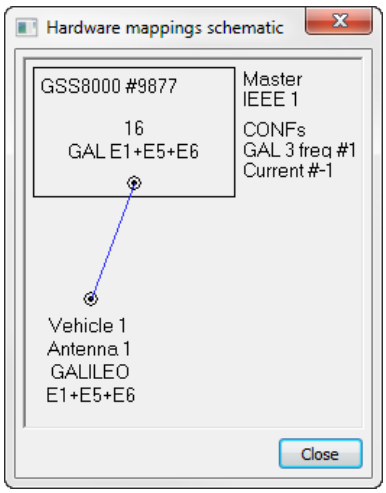
***2)*** *Do not change the value of the IEEE-488* **SRQ mask** *from its default value* ***EF****, unless instructed by a Spirent Global Support Engineer.*

***3)*** *Select an* ***External frequency*** *your signal generator supports see reference mm). The* ***Reference frequency*** *area of the* ***Options and Settings*** *dialog shows the status of the frequency reference. The green indicator in the figure shows the internal reference is in use. Indicators will show the status of any external reference you use.*




Use this dialog to select the required ‘1PPS’ Timer Output mode and the expected external reference frequency. You can also view the phase lock status. See reference mm) for more details.

Click **View mappings schematic…** to see a schematic of the mapping between your signal generator and the vehicle and antenna characteristics of the current scenario. This figure shows typical mapping for a GSS8000-series signal generator:




### 5.3.4.3 Trigger modes

This table outlines the trigger modes that Spirent signal generators can use, reference qq) gives more details.

| Mode | Description |
|---|---|
| Disabled | Does not rely on an external trigger pulse<br>The scenario starts on the next 1PPS after receiving the remote command ‘RU’ |


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| Mode | Description |
|---|---|
| Immediate | The signal generator's internal 1PPS signal remains halted until a rising edge from the remote system appears at the TRIG IN socket<br>***Notes***:<br>***1) For GSS9000-series, GSS7000 (and GSS8000-series) signal generators***<br>*If you stop the scenario and your simulator does not provide an input to the signal generator TRIG IN port, you must restart your signal generator before you can restart the scenario.*<br>***2) For GSS6700 signal generators***<br>*If you stop the scenario and your simulator does not provide an input to the signal generator TRIG IN port, you must restart your signal generator before you can restart the scenario.* |
| Delayed | The signal generator's internal 1PPS signal remains free running. You must apply a pulse to TRIG IN immediately following a 1PPS rising edge<br>***Notes***:<br>***1) For GSS8000-series signal generator users***<br>*If you stop the scenario, Spirent recommends you restart your signal generator by using one of the TIMER output ports in 1PPS mode connected to the TRIG IN port.*<br>*Alternatively if an external trigger is unavailable, Spirent recommends using one of the TIMER output ports in 1PPS mode connected to the TRIG IN port.*<br>***2) For GSS6700 signal generator users***<br>*If you stop the scenario and your simulator does not provide an input to the signal generator TRIG IN port, you must restart your signal generator before you can restart the scenario.*<br>*Alternatively if an external trigger is unavailable, Spirent recommends using one of the TIMER output ports in 1PPS mode connected to the TRIG IN port.* |

### 5.3.5 PLTS and ULTS - NovAtel message emulation

***Licenced feature****: You will need a licence to use this feature. Contact Spirent for licencing details.*

***Notes****:*

***1)*** *Spirent's GSS6700 (and the superseded GSS6560) signal generator support PLTS and ULTS*

***2)*** *Your licence file automatically sets your hardware configuration to support the NovAtel output*

***3)*** *SimGEN can only open COM ports up to and including COM9*

Certain phone location systems incorporate NovAtel GNSS receivers in the base station to provide location information. This information can assist the GNSS receiver in a phone; or assist the base station to compute the position of a phone using raw GNSS data from the phone. SimGEN supports both PLTS and ULTS, a Spirent system that tests these location systems. The title bar in the main SimGEN window identifies the available licence as the text "SimGEN PLTS -" or "SimGEN ULTS -" preceding the scenario name.

The PLTS and ULTS licences enable a SimGEN message stream that emulates the output of a NovAtel GNSS receiver. Currently, SimGEN supports PLTS and ULTS on GPS L1, GLONASS L1 and BeiDou B1, and provides:

- → GPS assistance messages on the RS-232 port you choose
- → GPS, GLONASS and BeiDou assistance messages as Data Streaming messages

To use PLTS and ULTS:

- → Use the appropriate remote commands in reference rrr) to set up Data Streaming messages for BeiDou, GLONASS and/or GPS
- → For GPS only, use Menu item **Options-*RS-232 port settings*** (page 5-28) to support NovAtel using these RS-232 port settings on the appropriate COM port:
  **Baud rate**: 9600
  **Data bits**: 8
  **Parity**: None
  **Stop bits**: 1
  **Flow control**: Software


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For BeiDou, GLONASS and/or GPS, select the Data Streaming messages you want to log in the ***Data Streaming Message Logger*** (page 26-32)

→ In the **Scenario contents** window, assign **Vehicle 1** as the base station

→ Ensure you assign **Vehicle 1**, the base station, as a static vehicle

→ Optionally, rename **Vehicle 1** with a name of your choice by selecting **Vehicle 1**, then right-click, select **Label…** and type the name in **Label prompt**

→ Create a new vehicle by selecting **Vehicle 1**, then right-click and select **New…** and **Insert** a vehicle type, this is **Vehicle 2**

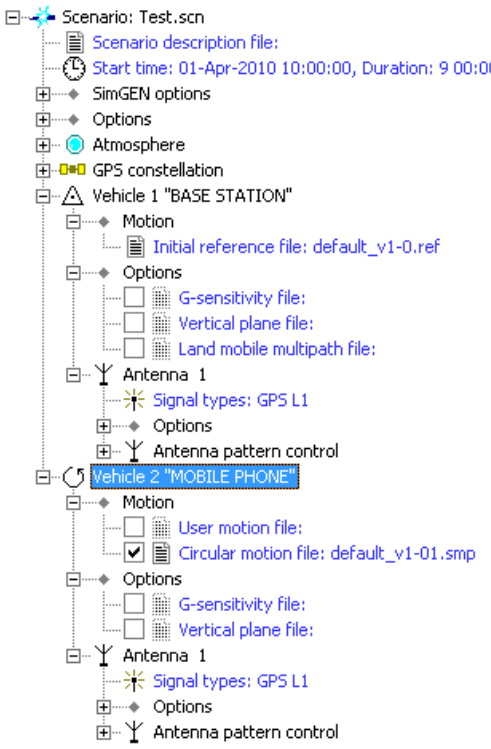
→ Assign the GNSS signal(s) you want to use with the mobile phone to Vehicle 2 Antenna 1. **Receive and Transmit antennas-*Associate a GNSS signal with an antenna*** (page 23-4) describes assigning a signal to an antenna

→ You must assign a motion model to Vehicle 2. This table details the motion types available for Vehicle 2 with PLTS and ULTS licences

| Licence type | Vehicle 2 motion - ULTS licence | Vehicle 2 motion - PLTS licence |
|---|---|---|
| Standard | Not available - the only available ULTS licence is 'ULTS with complex motion'. | Supports these motion types:<br>- ***Static model*** (page 21-4)<br>- ***Simple motion*** (page 21-5)<br>- ***Circular motion*** (page 21-6)<br>- ***User motion files*** (page 21-38) |
| Complex motion | As Standard PLTS licence plus:<br>- ***Rectangular racetrack*** (page 21-7)<br>- All ***Vehicle models*** (page 21-1) | Optional - contact Spirent for details<br>(As ULTS with complex motion) |

→ Optionally, rename **Vehicle 2** with a name of your choice by selecting **Vehicle 2**, then right-click, select **Label…** and type the name in **Label prompt**

This figure shows the contents of a typical ULTS scenario, with **Vehicle 1** labelled as "base station" and **Vehicle 2** labelled as "mobile phone".



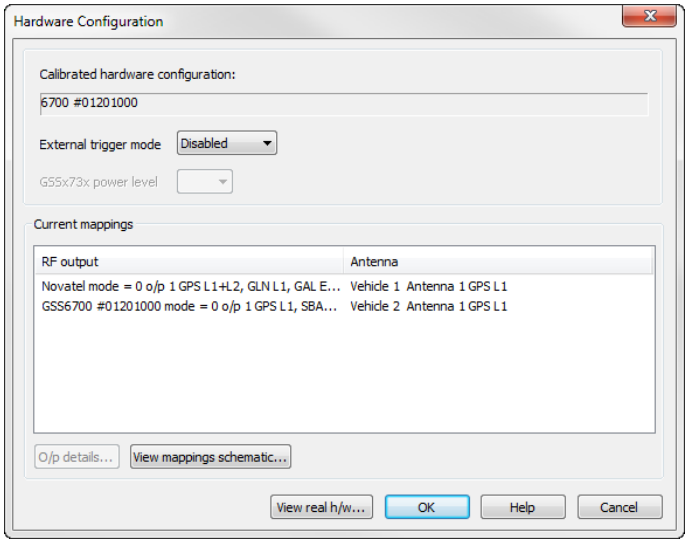


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### 5.3.5.1 Hardware configuration

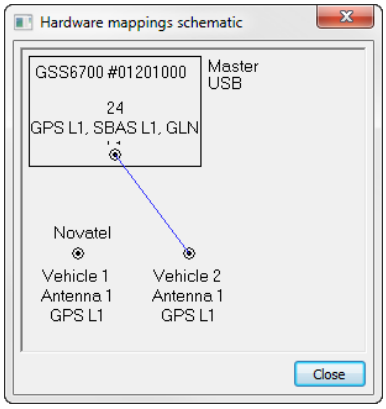
***Note: View mappings schematic…*** *shows a schematic of the interconnections your simulator uses and does not represent physical connections.*

The **Current mappings** area in the **Hardware Configuration** dialog, see the figure below, shows the mapping of the NovAtel receiver output and the signal generator to the vehicles and antennas in your scenario:




The Menu item ***Hardware Configuration*** (page 5-18) details how you configure SimGEN to operate with your signal generator.

Click **View mappings schematic…** to show hardware mapping. This figure shows Vehicle 1, the base station, assigned to GPS L1 and Vehicle 2, the mobile phone, also assigned to GPS L1 (the assignments of Vehicle 1 and Vehicle 2 need not be identical):

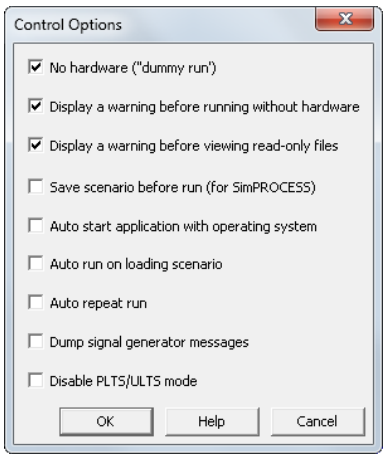



You can also set the NovAtel message delay for **all** scenarios using the Menu item ***General Options*** (page 5-15); or set the delay for a specific scenario using **SimGEN Options-*General options*** (page 7-1) from the **Scenario Contents** window.

### 5.3.5.2 Single vehicle scenario with PLTS and ULTS licences

The PLTS and ULTS licences automatically configure SimGEN to use two vehicles in a scenario (‘base station’ and ‘mobile phone’). You must disable PLTS or ULTS before you can use a single vehicle scenario, as follows:

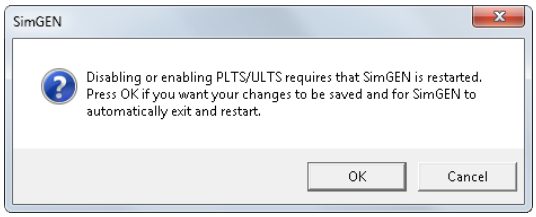
- → Ensure your licence is correctly installed in your SimGEN controller or 6700 Controller
- → Start SimGEN as normal. Notice the title bar of the SimGEN main window has the text “SimGEN PLTS -“ or “SimGEN ULTS - “ preceding the scenario name
- → Open the SimGEN **Options** menu item
- → Click **Control Options**. The PLTS/ULTS licence adds the **Disable PLTS/ULTS mode** option:




→ Select **Disable PLTS/ULTS mode**

→ Click **OK**

→ You must restart SimGEN before it can disable PLTS/ULTS, see the dialog below:




→ Click **OK** to restart SimGEN with PLTS or ULTS disabled

→ When SimGEN restarts, notice its title bar has the text “SimGEN (PLTS disabled) -” or “SimGEN (ULTS disabled) -” preceding the scenario name

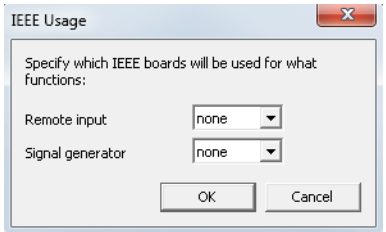
You can now run a single vehicle scenario.

To return to running a PLTS or ULTS scenario you must enable PLTS or ULTS in SimGEN. Open the **Options** menu, click **Control Options** and deselect **Disable PLTS mode** or **Disable ULTS mode**. Click **Yes / OK** so that SimGEN restarts with PLTS or ULTS enabled.

### 5.3.6 IEEE Usage

***Note**: GSS8000-series signal generators do not use IEEE-488 to communicate with the SimGEN Controller*

Use the **IEEE usage** dialog, below, to assign the IEEE-488 cards fitted in the SimGEN Controller to **Remote input** or **Signal generator**.




### 5.3.7 Message Reporting

**Notes**:

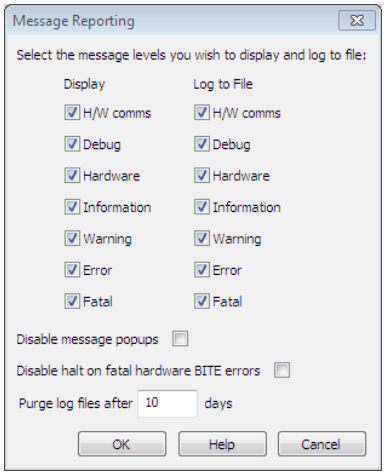
***1)** If you do not select **Disable message pop-ups**, SimGEN remains stalled until you acknowledge the message.*

***2)** The selections in this dialog do not output binary data.*

***3)** When using GSS9000-series and GSS7000 signal generators, enabling **Log to file-H/W comms** will result in over 95% of the log file containing H/W comms logs, with the log file size exceeding 10 GB.*
*Unless you specifically require a log of H/W comms, Spirent recommends you deselect **Log to file-H/W comms***


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This dialog controls the types of messages appearing in the ***System Messages*** window (page 3-15) and the messages SimGEN records in the log files.




Select the messages you want to **Display** and the messages you want to **Log to file**.

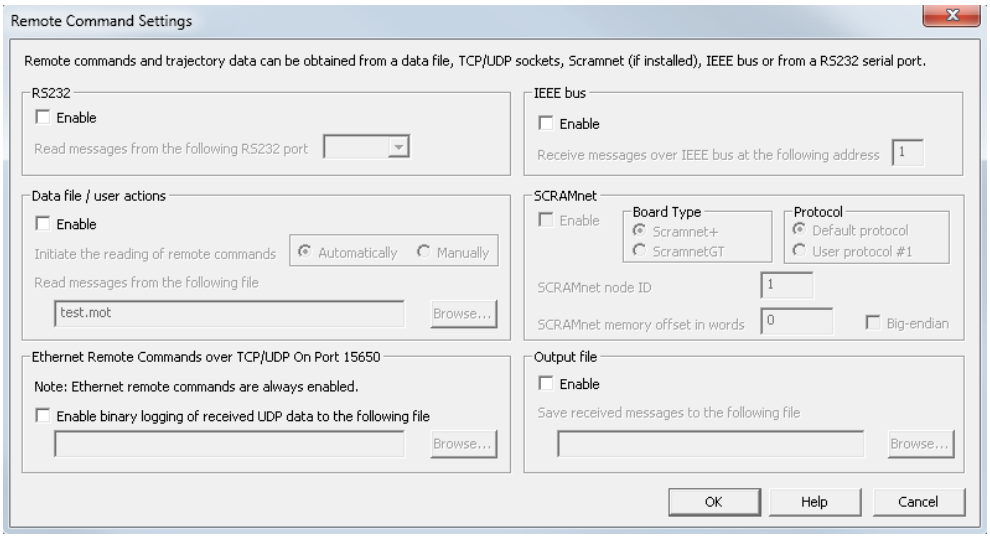
| | | | |
|---|---|---|---|
| **Display** | Displays messages you select in the **System messages** window.<br>The figure above shows the defaults. | | |
| **H/W comms** | Select to display all messages sent to, and received from, 7xxx, 8xxx and GSS9000-series signal generators in the **System messages** window. | | |
| ***Note**: SimGEN disables H/W Comms if your system operates with security sensitive features of SimGEN* | | | |
| **Debug** | Select to display debug messages | | |
| **Hardware, Information, Warning, Error, Fatal** | Displays these SimGEN messages | | |
| **Log to file** | On start up, SimGEN writes two separate log files to the folder *…\Positioning Application\logs*. The log filenames have the formats:<br>*PosApp_message_log_yyyy_mm_dd_hh_mm_ss.txt*<br>*PosApp_engine_message_log_yyyy_mm_dd_hh_mm_ss.txt* | | |
| **H/W comms** | Select to log all messages sent to GSS9000-series, 7xxx and 8xxx signal generators. | | |
| ***Note**: SimGEN disables H/W Comms if your system operates with security sensitive features of SimGEN* | | | |
| **Debug** | Select to log all debug messages | | |
| **Hardware, Information, Warning, Error, Fatal** | Logs these SimGEN messages | | |
| **Disable** | Select to disable the following: | | |
| **Message pop-ups** | Messages that require your acknowledgement before SimGEN will continue. Useful when you operate SimGEN using the remote control interface. | | |
| **Halt on fatal hardware BITE errors** | Contact Spirent before use | | |
| **Purge log files after days** | SimGEN retains all log files for the number of days you enter in the **days** area.<br>On start up, the PosApp engine deletes any file in the *…/logs* folder that was last modified over the number of **days** you enter. | | |
| | Units: integer days | Range: 1 to 1000 days | Default: 10 |
| ***Note**: SimGEN deletes any file in the …/logs folder that was last modified over the number of days you enter, it does not check if the file is a log file* | | | |


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## 5.3.8 Remote Command Settings

***Note**: C50r SimGEN Host users see **Important details for all users of the C50r SimGEN Host** (page 1-8)*

The **Remote Command Settings** dialog, see the figure below, lets you control SimGEN from a remote PC or a separate application program on the SimGEN Controller. This is useful if GPS simulations are part of an integrated test system, or you want to run simulations consecutively without intervention (as in production line testing). Reference qq) gives details of Spirent's remote control facilities.



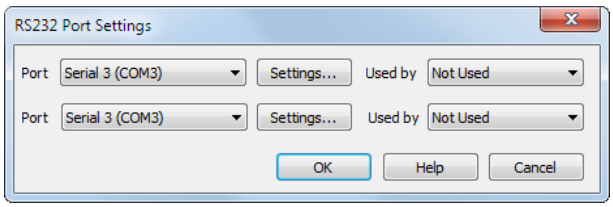

## 5.3.9 RS-232 port settings

***Notes only for SimGEN 5.0 onward when running on the C50r SimGEN Host**:*

***1)** Only this dialog uses the naming convention described in **Port** below. Do not use this naming convention when entering serial port names elsewhere; for example, when using the SimREMOTE commands in reference qq).*

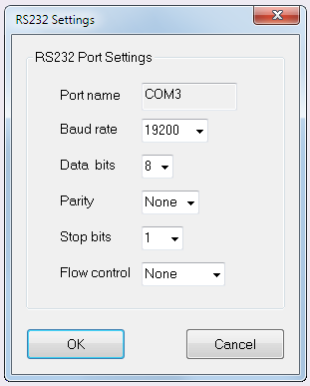
***2)** Serial ports are not available on the C50r SimGEN Host. You must use a USB-to-serial port adapter to provide an RS232 serial port. This dialog lists USB ports only.*

This figure shows the **RS232 Port Settings** dialog.




| | |
|---|---|
| **Port** | Lists all available serial ports as **Serial n (*physical name*)**, where:<br>**n** is the port number starting at 1<br>**(*physical name*)** is either:<br>**/dev/ttyUSBx** (Linux, with x starting at 0); or<br>**COMx** (Windows, with x starting at 1) |


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| | |
|---|---|
| **Settings** | Change the RS232 settings using these drop-down menus:<br>  <br> |
| ***Note for C50r SimGEN Host users only**: The C50r SimGEN Host uses a USB to RS-232 adaptor. Spirent are aware the C50r SimGEN Host does not detect certain adaptors when using the following Baud rates: 14 400, 128 000 and 256 000. Spirent recommends you do not use these Baud rates when using any USB to RS-232 adaptor.* | |
| **Used by** | Define the function of the port from: |
| **Barometric output** | See **Options-*Barometric height serial output file*** (page 22-19) |
| **GRAS output** | The Ground-based Regional Augmentation System is under development in Australia. Selecting GRAS outputs SBAS messages over RS-232 when an SBAS satellite is present in the simulation. |
| **LAAS output** | See ***GBAS constellation editor*** (page 15-1) |
| **NMEA input**, **output** and **RTCM output** | See **Options-**<br>***NMEA logging*** (page 8-9)<br>***NMEA output*** (page 8-11)<br>***RINEX output file (observation file)*** (page 8-18) |
| **NovAtel output** | Enabled with a ULTS licence.<br>Sets the RS-232 port for NovAtel message output, see ***PLTS and ULTS - NovAtel message emulation*** (page 5-23) |
| **Remote Commands** | Reference qq) details using remote commands |

From SimGEN 5.0 onwards and when using a C50r SimGEN Host, the following properties apply when using USB-to-serial port adapters:

1) The order in which Linux detects USB ports determines the port number. The first port Linux detects will be “ttyUSB0”, the second “ttyUSB1” and so on.

For example:

- → You connect USB cables from two of the C50r SimGEN Host USB ports to other devices.
- → The two devices open and Linux assigns the devices to ports “ttyUSB0” and “ttyUSB1”.
- → You then disconnect the USB cables from the two ports on the C50r SimGEN Host and immediately connect them in reverse order.
- → Port “ttyUSB0” is now connected to the device that was previously connected to “ttyUSB1”.
- → Port “ttyUSB1” is now connected to the device that was previously connected to “ttyUSB0”.

2) Linux assigns a new port if you unplug a USB cable from a USB port then plug the cable into the same port.

For example:

- → You connect a USB cable from a device to a C50r SimGEN Host USB port and the connected device opens.
- → Linux assigns this port as “ttyUSB0”.


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→ You now disconnect the USB cable and immediately re-connect it to the same USB port.

→ Linux assigns this port as “ttyUSB1”.

Assigning ports as described above will occur after you configure a specific C50r SimGEN Host serial port in the **RS232 Port Settings** dialog.

Properties 1) and 2) mean that, unless each USB-to-serial adapter is fixed and you cannot remove it, you cannot label a USB-to-serial adapter with a meaningful name, such as “Serial 1”. To name specific USB-to-serial adapters that are not fixed, you must disconnect each USB-to-serial adapter and reconnect the adapter you want to use as “Serial 1” first, followed by the adapter you want to use as “Serial 2” and so on.

## 5.3.10 User Actions Recording

***Notes**:*

***1)** SimGEN runs the commands in the User Actions file in sequence. If SimGEN cannot complete the action at the specified time it moves to the next command, it does not complete “missed” actions some time later. For example, if your User Actions file applies a pseudorange ramp to a satellite not currently visible, SimGEN (unable to find that satellite) will skip that action and move to the next action. If the scenario continues to run and that satellite subsequently rises, SimGEN will not apply the pseudorange ramp to the newly risen satellite.*

***2)** SimGEN assigns the RF Power Level to a specific Channel, not a specific SVID (also referred to as the Tx Channel).*
*This means that if you set an SVID to a specific RF Power Level and Channel, then later in your scenario force that SVID to a new Channel, SimGEN uses the Power Level assigned to the new Channel.*
*SimGEN does not “carry over” RF Power Levels originally assigned to an SVID.*
*If you want to assign a specific RF Power Level to a specific SVID, Spirent recommends you use the constellation parameter **Signal Control-Signal Power**.*

***3)** When a satellite rises, it is always set to **RF On**.*
*This means that if you set an SVID to **RF Off** and the satellite orbit takes that SVID out of view of your vehicle, when the satellite re-appears SimGEN sets that SVID to **RF On**.*
*If you want to permanently set the **RF Power Level** of a specific SVID to **Off**, Spirent recommend you deselect **Motion-orbits-present** (for example, see **GPS-Motion - Orbits** (page 10-21)) which will remove that SVID from the constellation.*

***Saving User Actions to a file*** describes creating a user actions file that records your actions while a scenario is running

***Replaying a User Actions file*** (page 5-31) describes subsequent use of this user action file in a scenario.

***User Actions file, *.act*** (page 8-38) describes creating a timer-ordered list of user actions without running a scenario.

### 5.3.10.1 Saving User Actions to a file

***Notes**:*

***1)** From SimGEN v2-81 on the User Actions file extension has changed from *.cmd to *.act.*
*You can specify User Actions files that use the old *.cmd extension. When you save the scenario, SimGEN automatically saves the User Actions file with the new *.act extension.*

***2)** When you record a User Action, you must carry out the action at the time into the scenario you want it to happen.*

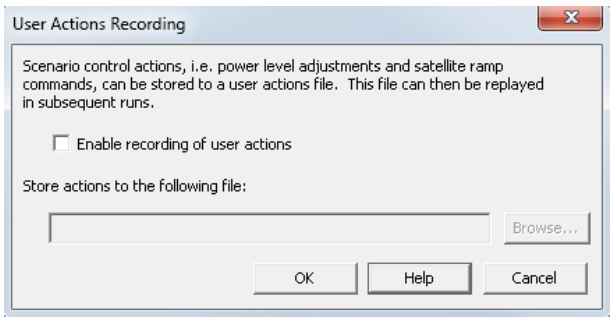
***3)** If you select an existing User Actions file, as in this figure (page 5-32), and then record new user actions; SimGEN adds the new user actions to the existing user actions. SimGEN also creates a new User Actions file with the same name as the existing User Actions file (strictly, this is not the same as overwriting the existing User Actions file as SimGEN creates a new file). SimGEN does not concatenate or interleave new actions with existing actions. Spirent recommends you use care when recording new user actions if the scenario contents window shows selection of an existing User Actions file.*

***4)** If the scenario contents window shows an existing User Actions file is not selected, then saving new User Actions to that existing User Actions file will overwrite the existing User Actions file.*

***5)** Spirent recommends you always use a name of your choice for a new User Action file and you do not overwrite default SimGEN files.*

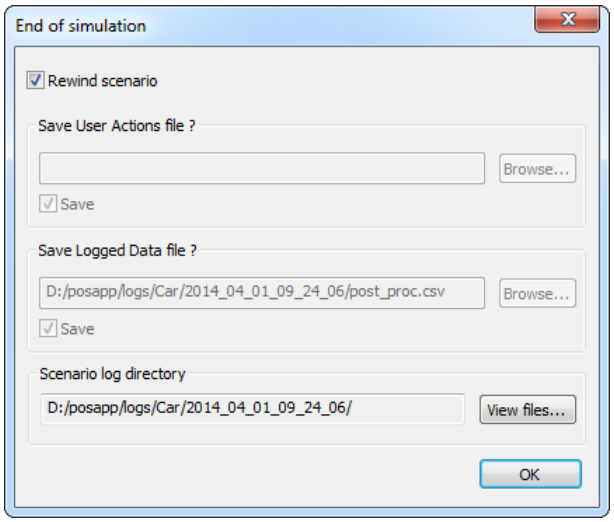
First, set up a User Actions file (**.act*). Select **Options-User Actions Recording-Enable recording of User actions**, which enables the **Store actions to the following file:** text area. Click **Browse** to save the User Actions file using a name of your choice to the current scenario folder (default); or navigate to an alternative folder:


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Now run the scenario using the toolbar button, see ***Scenario toolbar - left-hand side*** (page 6-1), and, while the scenario is running, carry out the actions you wish to record in the User Actions file.

When you stop the simulation, the **End of simulation** dialog appears:




For GSS9000-series signal generators using SimGEN on a C50r SimGEN Host and GSS7000 signal generator using SimGEN on the Embedded Host, this dialog displays the locations of the **User Actions file**, the **Logged Data file** and the **Scenario log directory**.

***Logging files*** (page 1-11) details the read-only nature of these locations.

Click **View files…** to open the Scenario log files.

For GSS8000-series, and earlier, signal generators using SimGEN on a SimGEN Controller, you can save the **User Actions file** and the **Logged Data file** to locations you specify by clicking **Browse…** and navigating to the location (**Scenario log directory** is not available for GSS8000-series, and earlier, signal generators).

| | |
|---|---|
| **Rewind scenario** | Select (default): rewinds the scenario automatically<br>Deselect: you must use the **Rewind** button on the toolbar to rewind the scenario. |

***Notes***:

***1)*** *C50r SimGEN Host users see* ***Important details for all users of the C50r SimGEN Host*** *(page 1-1) for details on logging file locations*

***2)*** *After stopping a scenario, you must rewind it before you can run it again, or make changes to its parameters*

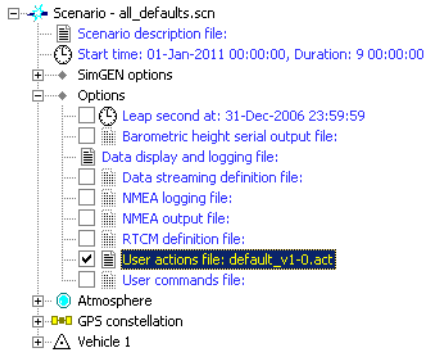
### 5.3.10.2 Replaying a User Actions file

To replay a User Actions file, you must first add that User Actions file to the scenario:

→ In the scenario contents window, select **Options-User actions file:**

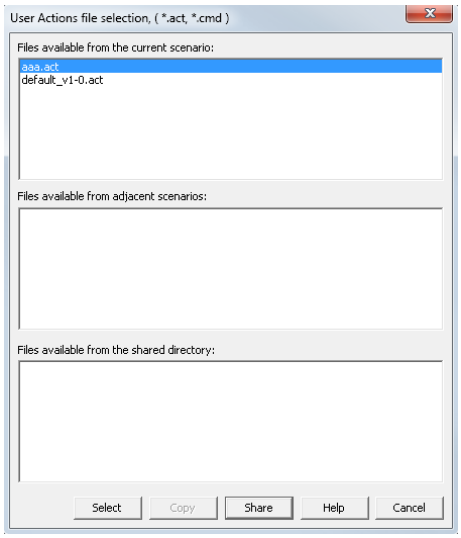
→ A tick in the box next to **User actions file:** indicates SimGEN will use the User Actions file (notice SimGEN enters the default User Actions file *default_vx-yy.act*):


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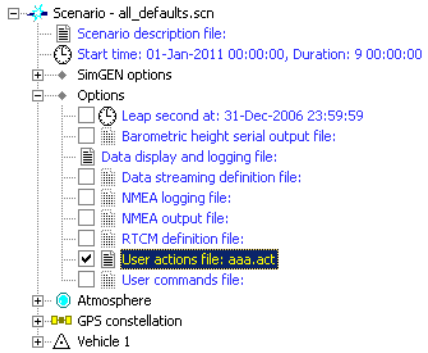



→ To choose a different User Actions file, ensure **User actions file:** is highlighted and click **Select**.

→ Select the User Actions file you want to use, see **Configuring scenarios-*Adding files to a scenario*** (page 4-17). This figure shows selecting *aaa.act*:




→ SimGEN loads the User Actions file you select into the scenario. The figure below shows the scenario using the User Actions file *aaa.act*:




### 5.3.10.3 Operating mode with a User Actions file and an interference file

***Note**: You can only use an interference file (*.itf) with Spirent's GSS7765 or GSS4765 ISS - see reference nn).*

This table details the mode of operation if a User Action file (*.*act*) and an interference file (*.*itf*) are present in the same scenario:

| User Actions file (*.act) | Interference file (*.itf) | Mode of operation |
|---|---|---|
| ✘ | ✘ | Interactive interference mode |
| ✘ | ✓ | Replays the interference file commands |


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| User Actions file (*.act) | Interference file (*.itf) | Mode of operation |
|---|---|---|
| ✓ (interferer commands present) | ✘ | Replays the User Actions file commands |
| ✓ (interferer commands present) | ✓ | Replays both User Actions file commands AND interference file commands |
| ✓ (interferer commands not present) | ✓ | Interactive interference mode (the User Actions file does not affect the interactive interference mode) |
| ✓ (interferer commands not present) | ✓ | Replays the interference file commands |

### 5.3.11 User Action files created in SimREMOTE

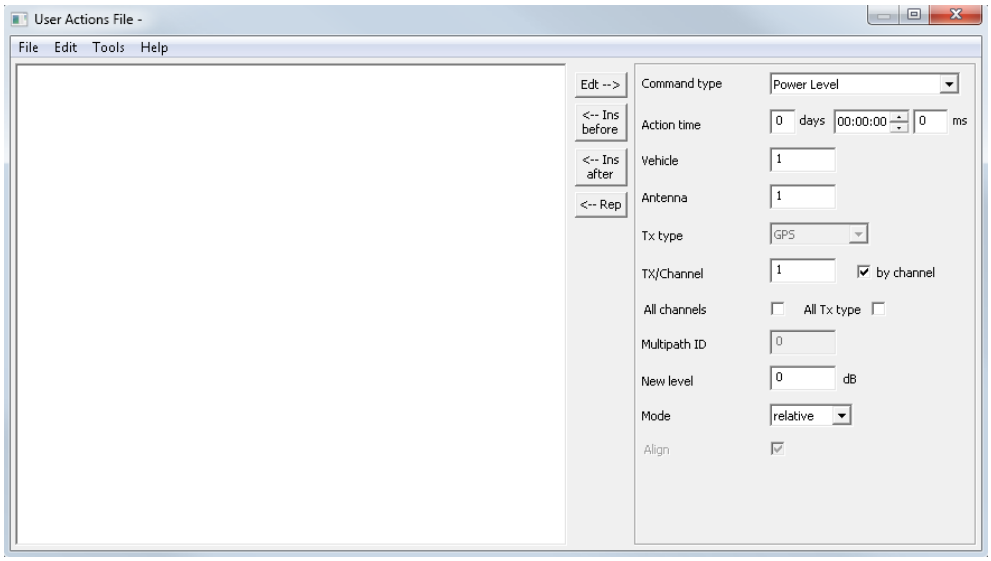
***Note**: When running a User Actions file created in SimREMOTE, you cannot use commands that change the scenario.*

A user action file you create using ***User Actions Recording*** (page 5-30) can use any SimREMOTE command that does not change a scenario, see Note above. Reference qq) describes using SimREMOTE and also details using User Actions files in SimREMOTE.

### 5.3.12 List Editor

***Note**: You must ensure your list of User Actions is correctly time-ordered. If the User Actions are not in time-order, SimGEN may stall and not complete the remaining User Actions.*

SimGEN uses a List Editor to create ordered lists of actions to create User Actions files. You must use the List Editor particularly if the User Actions file uses commands at time zero. This figure shows a typical List Editor dialog:




#### 5.3.12.1 Using the List Editor

***Note**: When you start to edit an existing file, the editor selects the first action.*

To create the first action, enter the data in the text boxes in the right-hand area and click either **Ins before** or **Ins after** to transfer the initial action to the left-hand area.

When you create subsequent actions, the editor selects the most recently created action in the left-hand area.

Delete an action from the left-hand area by highlighting it and pressing the keyboard Del key.


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#### 5.3.12.2 Edt button

***Note**: You must transfer the edited action to the left-hand area to ensure it is stored in the User Actions file.*

To edit an existing action:

- → Select the action in the left-hand area.
- → Click **Edt** to transfer the data to the text boxes in the right-hand area.
- → Edit the data in the right-hand area.
- → Click **Ins before** or **Ins after** to transfer the new data to the left-hand area.

#### 5.3.12.3 Ins before button

***Note**: If you click **Ins after** you cannot insert the action since its start time is earlier than action n, where n is the number of the selected action in the left-hand area.*

To create an action that you want to occur **before** the time of the action currently selected:

- → Enter the data in the text boxes in the right-hand area.
- → Click **Ins before** to transfer the new action to the left-hand area.
- → This action appears before the time of the action previously highlighted.

You can use **Ins before** to insert actions that occur at the same time. For example, you can insert an action that changes SVID to occur before or after another action occurring at the same time.

#### 5.3.12.4 Ins after button

***Note**: If you click **Ins before** you cannot insert the action since its start time is later than action n, where n is the number of the selected RLM in the left-hand area.*

To create an action that you want to occur **after** the time of the action currently selected:

- → Enter the data in the text boxes in the right-hand area.
- → Click **Ins after** to transfer the new action to the left-hand area.
- → The action appears after the time of the action previously highlighted.

You can use **Ins after** to insert actions that occur at the same time. For example, you can insert an action that changes SVID to occur before or after another action occurring at the same time.

#### 5.3.12.5 Rep button

***Note**: You can also create or edit a User Actions file using a standard text editor.*

To replace an existing action:

- → Select the action in the left-hand area.
- → Click **Edt** to transfer the data to the text boxes in the right-hand area.
- → Edit the data in the right-hand area.
- → Click **Rep** to replace the selected action with the edited data in the right-hand area. Replacing an action is subject to the limitations of the time-ordered list of actions:
- → You can replace the first action with an action that occurs earlier.
- → You can replace the first action with an action that occurs later, up to the time of the second action.
- → You cannot replace the first action with an action that occurs later than the second action.
- → You can replace the last action with an action that occurs earlier, up to the time of the second from last action.


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→ You can replace the last action with an action that occurs later.

→ To delete an item from the list in the left-hand area, select it and press the Del key.

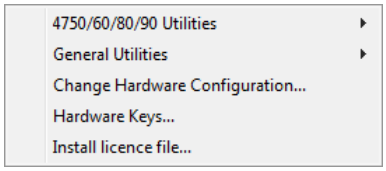
Once complete, save the file in the normal manner and then associate it with the scenario, see ***User Actions Recording*** (page 5-30).

# 5.4 Tools

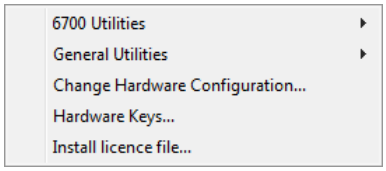
This section details the Tools available in SimGEN.

The signal generator you assign to your scenario using ***Hardware Configuration*** (page 5-18) determines the entries you see in the **Tools** menu and in the sub-menus. For example:

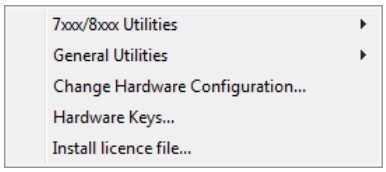
47xx:



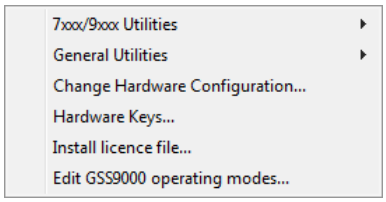

GSS6700:




GSS7xxx and GSS8xxx:




GSS7000 and GSS9000-series:




## 5.4.1 Utilities

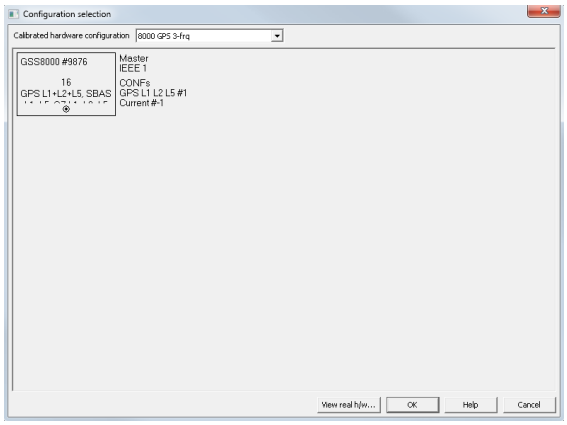
***SimGEN utilities*** (page 26-1) details all utilities available in SimGEN. Reference zz) describes using SimPROCESS.

## 5.4.2 Change Hardware Configuration

***Note**: If you use a single signal generator, or a single possible configuration, you do not need to use **Change Hardware Configuration.***

If you use several signal generators and additional items such as Interference Simulators, you can employ different configurations with SimGEN. Some of these configurations will require signal level and phase offsets be applied to signals to compensate for the inter-box connections. All these possible configurations, together with any associated calibration offsets, are stored in the file *sig_gen.txt* located in the SimGEN installation folder. Spirent normally configures this file before system delivery and supplies the file *sig_gen.txt* on CD, together with your hardware licence keys.

When you select **Change Hardware Configuration**, SimGEN first warns you about changing hardware and then displays the dialog.



**Calibrated hardware configuration** shows the configurations given in *sig_gen.txt*. When you select a configuration, it is selected it is displayed graphically in the area below. Click **OK** to select the configuration displayed.

If you are using a signal generator with a combined L1/L2 RF output capability, use **Change Hardware Configuration** to swap between Multi-o/p and combined o/p modes of operation:

→ For Multi-output operation use: *xxxxx* Multi-output mode

→ For Combined output operation use: *xxxxx* Combined-output mode

In both cases *xxxxx* is the signal generator.

### 5.4.3 Edit GSS9000 operating modes

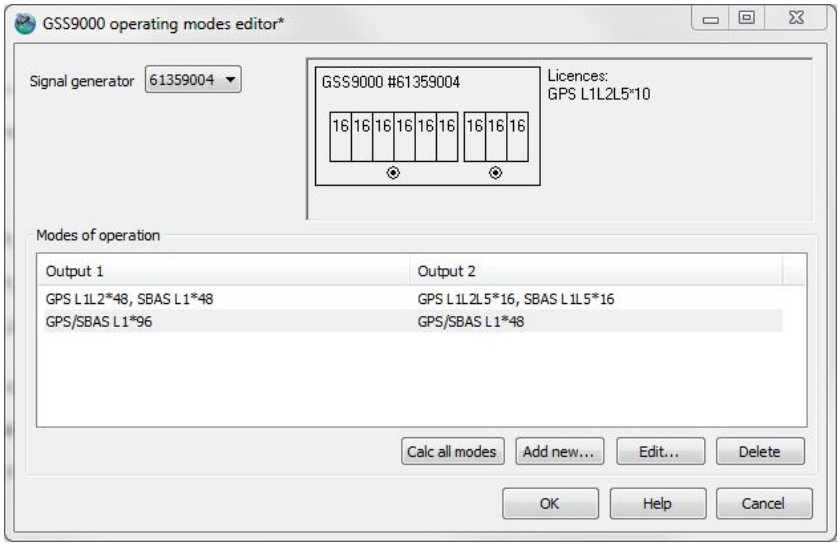
***Note**: Use with GSS9000-series signal generators where the number of channel banks and the number of licences is too large for SimGEN to calculate automatically all possible operating modes*

Each GSS9000-series signal generator uses from one to ten channel banks to provide 16 channels per bank of simulated GNSS signals. Your licence sets up the channel bank(s) to generate a single frequency for a specific constellation. SimGEN stores your licences in a “cabinet”.

Normally, SimGEN calculates all possible operating modes for GSS9000-series signal generators. However, SimGEN cannot calculate all operating modes when you have a large cabinet of licences and a signal generator using many channel banks.

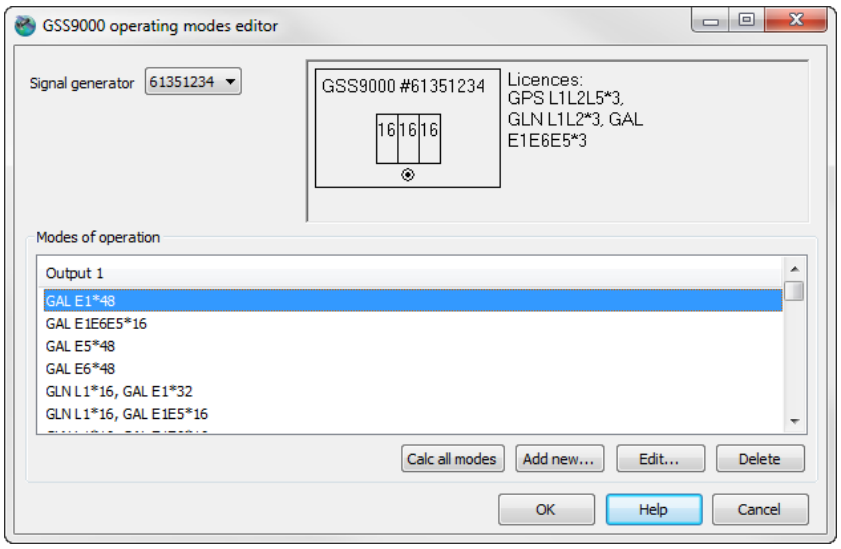
In this case, use the **GSS9000 operating modes editor** to manually assign a specific operating mode.

This figure shows the editor for a typical dual-output signal generator:



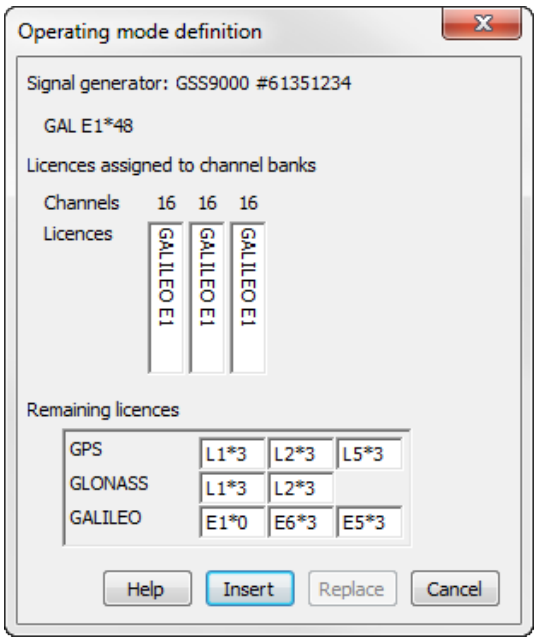

This figure shows the editor for a typical single-output signal generator:


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| | |
|---|---|
| **Signal generator** | Select the serial number of the GSS9000-series signal generator whose operating mode you want to set |
| **Modes of operation** | Select a mode from those displayed (see highlighted **Modes of operation** in the figures above). A schematic of the signal generator using the mode you select appears to the right of **Signal generator**. The signal generator serial number appears after **#**.<br>***GSS9000-series and GSS7000 signal generators*** (page 5-18) describes the numbers (channels) and letters (constellations) shown in the rectangles that represent signal generator channel banks.<br>Single channel signal generators show the available channel banks.<br>The single-output figure above shows a total of **9** licences are available: **GPS L1L2L5*3**, **GLN L1L2*3**, **GAL E1E6E5*3**<br>Dual-output signal generators show how the channel banks are distributed between each output (six channel banks for output 1 and three channel banks for output 2 in the figure above)<br>The dual-output figure above shows a total of **10** licences are available: **GPS L1L2L5*10**. |
| **Calc all modes** | Forces SimGEN to recalculate all operating modes<br>Click to recalculate the “default” operating modes |
| ***Note**: Where SimGEN has automatically calculated all possible operating modes, it displays them in the **Modes of operation** area. If you then create an operating mode and click **Insert** to add it to the **Modes of operation** area, SimGEN assumes you want to reduce the operating modes to a smaller set you define. This will delete all other operating modes.*<br>*Click **Calc all modes** to force SimGEN to recalculate and display all operating modes.* | |
| **Add new…** | Create a new operating mode in the **Operating mode definition** dialog, see below, which shows the single-output signal generator from the figure above. |
| **Edit…** | Edit an existing operating mode in the **Operating mode definition** dialog, see below, which shows the single-output signal generator from the figure above |
| **Delete** | Deletes the operating mode you select |


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| | |
|---|---|
| **Signal generator:** | Shows the current operating mode of the selected signal generator.<br>The figure above shows a single-output GSS9000-series signal generator with three channel banks, all assigned to Galileo E1 (48 channels in total). |
| **Licenses assigned to channel banks** | This area shows the current allocation of licences to the channel banks in your signal generator (notice each channel bank supports a maximum of 16 channels at one frequency).<br>In the figure above, the allocations are:<br>First channel bank - 16 channels to Galileo E1<br>Second channel bank - 16 channels to Galileo E1<br>Third channel bank - 16 channels to Galileo E1<br>(making 48 channel in total, all assigned to Galileo E1) |
| **Remaining licences** | This area shows your remaining licences that are currently unassigned to any channel banks.<br>The figure above shows there are no Galileo E1 licences available (the figure above shows three channel banks that use one each of the three available Galileo E1 licences). The GPS constellation shows three licences available for each of L1, L2 and L5 and three licences available for GLONASS L1 and L2. There are three licences available for Galileo E5 and E6. |

You can assign licences by either clicking **Add new…** to create a new operating mode, or click **Edit …** to edit an existing operating mode. Using the 48 channel, Galileo E1, example shown in the figure above:

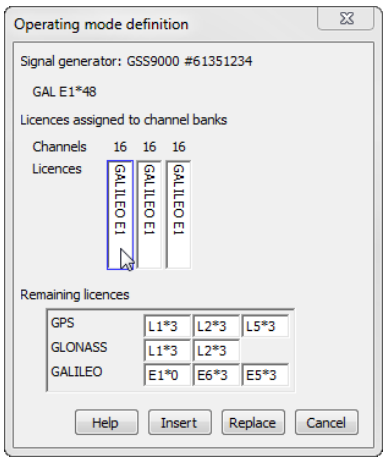
Remove one Galileo E1 licence from **Licences assigned to channel banks** and return it to the **Remaining licences area** as follows:

→ Click **GSS9000 operating modes editor-Edit**…

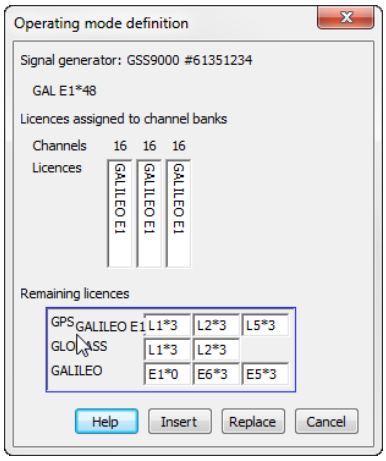
→ Mouse over one of the three channel banks to highlight the channel bank and click to select it:



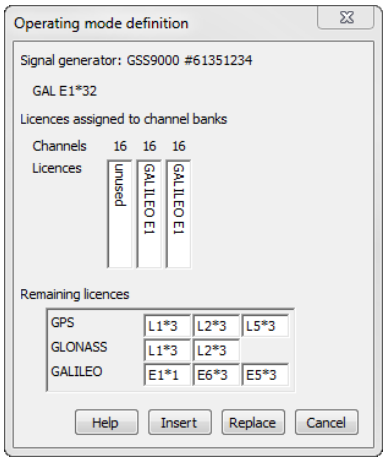
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→ Move this selection to the **Remaining licences** area and click to drop the licence into the area:



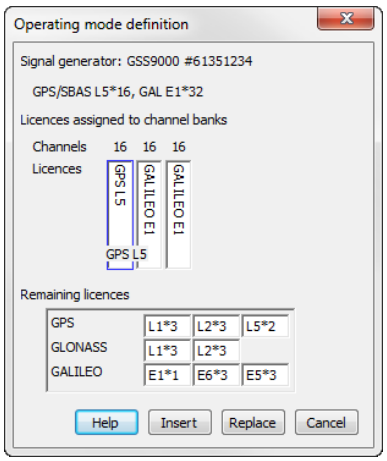

→ The Galileo E1 licence now appears in the **Remaining licenses** area and the channel bank shows it is **unused**:




Now add a licence to the **unused** channel bank:

→ Click on a licence in the **Remaining licences** area and move this selection to the **unused** channel bank, then click to drop the selection into that channel bank. For example, a GPS L5 licence:


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Finally insert the new operating mode:

***Note**: Where SimGEN has automatically calculated all possible operating modes, it displays them in the **Modes of operation** area. If you then create an operating mode and click **Insert** to add it to the **Modes of operation** area, SimGEN assumes you want to reduce the operating modes to a smaller set you define. This will delete all other operating modes.*

*Click **Calc all modes** to force SimGEN to recalculate and display all operating modes.*

→ Click **Insert** to insert this operating mode into the **Modes of operation area** in the **GSS9000 operating modes editor**.

→ Click **OK** to save this mode

Alternatively, click **Replace** to replace the operating mode you originally selected with the new operating mode you created.

You can create a new operating mode using the same method as described above after clicking **GSS9000 operating modes editor-Add new…**

In addition to the above, you can:

→ Double-click any **Mode of operation** to open the **Operating mode definition dialog**

→ Swap licences between channel banks by selecting the licence in the channel bank, moving to another channel bank and clicking.
You can also swap licenses to unused channel banks in the same way (notice you must move a licence, you cannot move an unused channel bank)

→ Drag a licence from the **Remaining licences** area over channel banks (up to the maximum number of licences you have for that frequency) - a fast way to set up channel banks to use a single frequency

***Licence management*** (page 1-9) gives more details on licencing.

### 5.4.3.1 Using dual-output GSS9000-series signal generators as single output signal generators

***1)** Spirent supplies each dual-output GSS9000-series signal generator with a custom loopback cable identified with the signal generator serial number. The parameters of this cable are saved to a calibration file. Replacing this Spirent-supplied cable with any other cable may result in your signal generator operating out of specification for RF power level and 1PPS to RF delay.*

***2)** When you finish using your dual-output signal generator as a single output signal generator, you remove the custom loopback cable as described below.*

You can use your dual-output GSS9000-series signal generator as a single-output signal generator by:

→ Removing the terminations Spirent fits to the EXT SIG IN 1 port and the HIGH LEVEL 2 port. Store the terminations in a safe place.


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→ Connecting the custom loopback cable that Spirent supplies with each dual-output signal generator from the EXT SIG IN 1 port to the HIGH LEVEL 2 port, as in the figure below (reference sss) gives details on using GSSS9000-series signal generators):




→ Now, in SimGEN go to **Tools-*Edit GSS9000 operating modes*** (page 5-36) and setup up the channel banks according to the capabilities of your GSS9000-series signal generator. For example, if your signal generator is licenced to generate GPS L1, L2 and L5, you must configure generation of GPS L1, L2 and L5 from the same output port.

When you have finished using your dual-output signal generator as a single-output signal generator, you must:

→ Remove the custom loopback cable you fitted to the EXT SIG IN 1 port and HIGH LEVEL 2 port. Store this cable in a safe place.

→ Fit the terminations (you previously removed) to the EXT SIG IN 1 port and the HIGH LEVEL 2 port.

→ Now, in SimGEN go to **Tools-*Edit GSS9000 operating modes*** (page 5-36) and setup a dual-output operating mode.

### 5.4.4 Hardware keys

***Notes***:

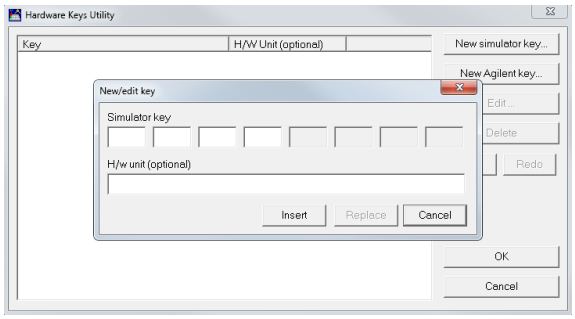
***1)*** *Where a system uses two or more signal generators, Spirent designate one signal generator as the "master" and the other(s) as "auxiliary"*

***2)*** *From SimGEN version 2-40 to 2-84, hardware keys are required for ALL supported signal generators*

***3)*** *From SimGEN version 2-90 onwards, only "auxiliary" signal generators need hardware keys. Existing user upgrading from SimGEN versions up to 2-90 to any SimGEN version after 2-90 can leave both "hardware" and "auxiliary" keys in place*

***4)*** *For all versions of SimGEN, the master signal generator must be present to allow a simulation to run*

Spirent use Hardware keys to assign SimGEN to a specific signal generator and so prevent unauthorised use. Spirent derives the 16-digit hexadecimal number keys from the serial number of your signal generator(s). Spirent pre-installs the keys before system delivery. However, you can enter these keys using the **Hardware keys** utility:




Existing keys appear in the Keys area. To add a new key:

→ Click **Tools-Hardware Keys...**

→ Click **Add Simulator Key…**

→ Enter the Key and the optional details of the signal generator in the **Add Simulator Key-H/w unit (optional)** area of the dialog

→ Click **Add Agilent Key...** to add a GSS7765 or STR4765 Agilent key

→ Click **OK**

### 5.4.5 Install licence file

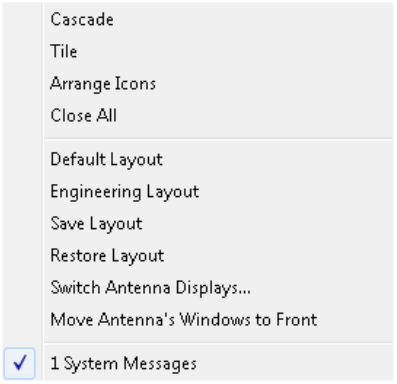
SimGEN can only use one licence file at a time. Use this dialog to overwrite your existing licence file with a new licence file. Notice the licence file must use the extension **.txt*, but can have any name. Using this dialog will rename your licence file with the correct licence filename for SimGEN, *lservc*.txt*.

Navigate to the licence file (*lsevrc*.txt*) you want to use and click **Open**.

You must restart SimGEN after installing a new licence file.

## 5.5 Window

You can save the layout of the windows you see. Select the windows you want to see (the layout) using Windows standard **View** menu. Save this layout using **Save Layout**:

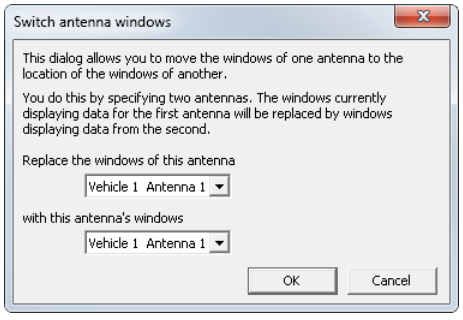



| | |
|---|---|
| **Default Layout** | Select to change to Spirent's default window layout |
| **Engineering Layout** | Windows displayed when SimGEN starts |
| **Save Layout** | Saves the current layout of the SimGEN windows |
| **Restore Layout** | Go to the previously saved window layout |
| **Switch Antenna Displays** | See ***Switch antenna displays*** |

### 5.5.1 Switch antenna displays

***Note**: This option is only visible when a scenario uses two, or more, antennas.*

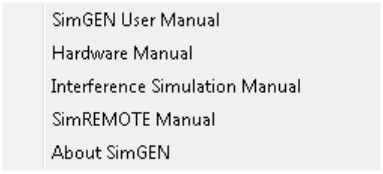
This gives a simple way of replicating all currently visible windows associated with one antenna, with that of another antenna. For example, after you have enabled and arranged all the required window displays for Antenna 1 of a dual antenna scenario, you can use **Switch antenna displays** to display all the corresponding data for Antenna 2:

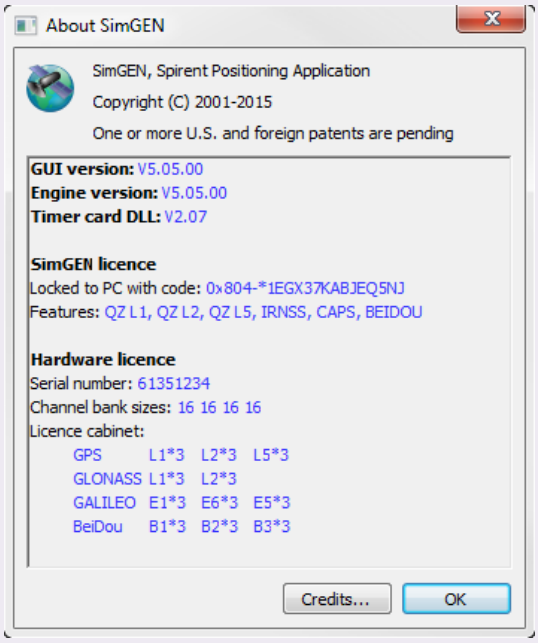




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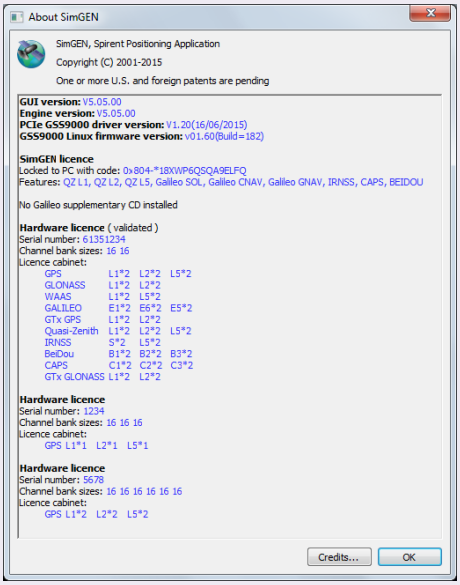
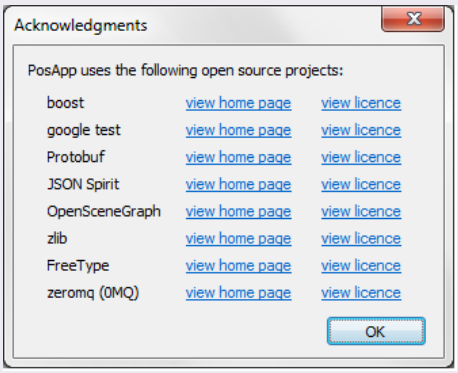
## 5.6 Help




| | |
|---|---|
| **SimGEN User Manual** | Opens the help file version of this document. |
| **Hardware Manual** | Opens the pdf version of reference mm). |
| **Interference Simulation Manual** | Opens the help file version of reference nn) |
| **SimREMOTE Manual** | Opens the pdf version of reference qq) |
| **About SimGEN** | **For GSS8000-series and earlier signal generators**<br>Click to display version numbers and licence details:<br>  |




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| About SimGEN | **For GSS9000-series and GSS7000 signal generators**<br>Click to display version numbers and licence details, including hardware licence details and firmware details:<br>  <br>**Hardware configuration-*GSS9000-series and GSS7000*** signal generators (page 5-18) describes the details in **Hardware licence**<br>For all signal generators, click **Credits…** to show open source library acknowledgements:<br>  |
|---|---|






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# 6 Toolbar and Status bar

This Chapter reviews all the items on the Toolbar and Scenario Toolbar, situated at the top of SimGEN screen, and the Status bar, which is located at the bottom of the SimGEN screen.

## 6.1 Toolbar

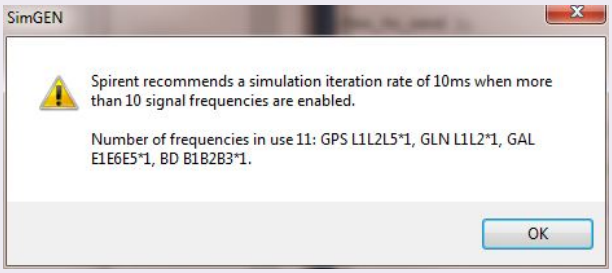
Hide or display Toolbars using the **View** menu. This table details the Toolbar buttons:

| | |
|---|---|
|  | Print the underlying XML data of the file you select in the **Scenario Contents** window. This button is only enabled after you select a printable file |
|  | Shows the current software version number |
|  | Click and move the “?” cursor to the item on which you require help |
|  | Displays the ***System Messages*** window (page 3-15) |
|  | Manually switch the remote input, see the menu item **Options-*Remote Command Settings*** (page 5-28) and reference qq) |

## 6.2 Scenario toolbar - left-hand side

| | |
|---|---|
|  | **Rewind** - When a simulation ends, SimGEN displays the end conditions of the scenario, see ***Saving User Actions to a file*** *(page 5-30)* for details of the **End of simulation** dialog. |
| ***Note**: After stopping a scenario, you must rewind it before you can make changes to its parameters or run it again* | |
|  | **Run -** Runs the current scenario. (Or **arms** it to wait for an external hardware trigger in external trigger modes) |

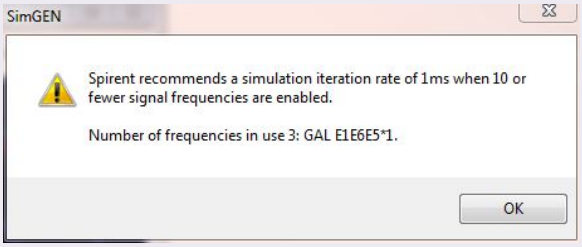
***Note for users of two, or more, GSS9000-series signal generators**: When operating at 1 millisecond Simulation Iteration Rate, there is a limit to the number of constellations and frequencies you can use in your scenario. After you click **Run**, SimGEN checks your scenario and hardware configuration and displays this window if your scenario is affected:*




*Click **OK** to continue running your scenario, in which case it may experience stability issues.*
*If you see this window, Spirent recommends you click **OK**, then stop your scenario and change to using 10 milliseconds Simulation Iteration Rate.*
*The Menu item **General Options** (page 5-15) details setting the Simulation Iteration Rate.*


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***Note for all GSS9000-series signal generator users**: Spirent recommends you always run at the highest Simulation Iteration Rate possible. After you click **Run**, SimGEN checks your scenario and hardware configuration and displays this window if you can use a higher Simulation Iteration Rate:*




*Click **OK** to continue running the scenario, in which case your simulated signal fidelity may be compromised. If you see this window, Spirent recommends you click **OK**, then stop your scenario and change to using 1 millisecond Simulation Iteration Rate.*
*The Menu item **General Options** (page 5-15) details setting the Simulation Iteration Rate.*

| | |
|---|---|
|  | **Turbo** - lets you quickly preview a simulation to determine satellite coverage. **Turbo** runs the simulation at a faster rate than real-time (up to 30 to 40 times faster at 10 milliseconds iteration rate).<br>Before using **Turbo**, you must select **No hardware**, see the menu item **Options-*Control Options*** (page 5-13)<br>The **System Messages** window displays a message every minute of “real-time” showing the elapsed time in the scenario. |
|  | **Turbo Rate** slider - varies the Turbo speed. Fully right for maximum speed fully left for normal speed. |
|  | **Stop** - Stops a running scenario |

## 6.3 Scenario toolbar - right-hand side

| | |
|---|---|
|  | Display the **Scenario Contents** window.<br>See **Configuring scenarios-*Defining a scenario*** (page 4-4) |
|  | Display the scenario **Date / time** window.<br>See **Main display windows-*Date / Time*** (page 3-3) |
|  | Display the **Pseudorange Ramps** window.<br>See ***Embedded multipath*** (page 24-17) |
|  | Display **NMEA** messages.<br>See ***NMEA logging*** (page 8-9) |
|  | Display **RTCM** differential correction messages.<br>See ***RINEX output file (observation file)*** (page 8-18) |
|  | Display the **Data Plots** window.<br>See ***Plotting data versus time*** (page 25-14) |
|  | Display the **Data Display** window.<br>See ***Displaying run-time data*** (page 25-13) |
|  | Display the **Data Logging** window.<br>See ***Log data to a file*** (page 25-10) |
|  | Select a particular vehicle / antenna where your scenario has multi-vehicle or multi-antenna capability (visible only if you use more than one vehicle / antenna) |
|  | Bring the current **Antenna** window to the front.<br>Only visible if the scenario uses more than one antenna |
|  | Display the **Position Details** window for vehicle / antenna.<br>See ***Vehicle Antenna Position Details*** (page 3-4) |


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| | |
|---|---|
|  | Display the **Vehicle Dynamics** window for the vehicle / antenna<br>See ***Vehicles and antennas*** (page 3-1) |
|  | Display the **Ground Track** window for the selected vehicle / antenna.<br>See ***Ground Track*** (page 3-12) |
|  | Display the **Power Levels** Graph window for the selected vehicle / antenna.<br>See ***Power Levels Graph*** (page 3-9) |
|  | Display the **Power Adjustment** window for selected vehicle / antenna.<br>See ***Power Adjustment*** (page 3-11) |
|  | Display the **Signals Received** window for the selected vehicle / antenna.<br>See ***Received Signals*** (page 3-7) |
|  | Display a **Sky Plot** showing satellite positions with respect to the vehicle / antenna.<br>See ***Sky Plot*** (page 3-4) |
|  | Display the **Channel Assignments** window.<br>See ***Channel assignment and multipath types*** (page 24-1) |
|  | Display the Current antenna attenuation pattern window.<br>See ***INS error models*** (page 22-1) |
|  | Display the Interference window.<br>See reference nn) |

## 6.4 Status bar

This is always visible at the bottom of the SimGEN main window: This table details the areas of the Status bar.

| | |
|---|---|
| Ready | Shows “Ready” or function of toolbar buttons when hovering |
| 11-Sep-2008 00:00:00 | Start date and time of current scenario |
| LOCKED | Local_Lockout status<br>Enabled - flashing white text “LOCKED” on red background<br>Disabled - grey text<br><br>Transfers command of a scenario from the SimGEN interface to using remote commands from a remote control interface.<br>As soon as you enable Local_Lockout, you cannot use SimGEN to start a scenario or use SimGEN to access anything that affects a running scenario.<br>You can continue to use the SimGEN interface to read scenario data; however, Local_Lockout disables certain buttons and menu items. SimGEN displays a warning if you try to edit files that will affect a running scenario:<br>  <br><br>Reference qq) gives more details on using Local_Lockout. |
| LOG | Grey text - data logging disabled<br>Solid green background - data logging enabled. See **Accessing Simulation (Quick-Look) data-*Log data to a file*** (page 25-10).<br>Flashing green background - data logging taking place |
| H/W | Shows state of signal generator.<br>Amber background - SimGEN running in “no hardware” mode, with the signal generator disabled or disconnected.<br>Green background - running in normal mode with a signal generator connected. |


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| | |
|---|---|
| Compatible h/w | Signal generator and scenario compatibility.<br>Shows flashing red “Incompatible h/w” if signal generator is unable support the scenario. |
| Ready to run | Shows the status of the simulation as: “Loading”, “Ready to run”, “Arming”, “Armed”, “Running”, “Paused” or “Ended”. These states are the same as the simulation status returned to remote control programs. |



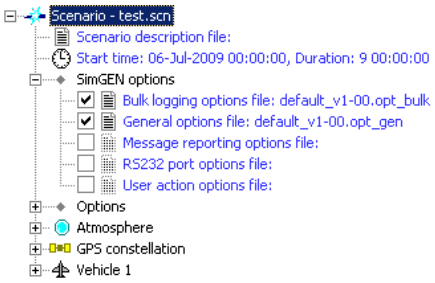
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# 7 SimGEN options

Up to SimGEN version 2-89, you could assign Options 'globally' by using the menu item **Options** and SimGEN then applied your choice of **Options** to all scenarios.

From SimGEN 2-90 onwards:

- The ***Options*** (page 5-1) menu item sets global options that apply for all scenarios
- **<scenario name>-SimGEN options** sets options that only apply to **<scenario name>** - the specific scenario you are editing in SimGEN
- Options you set using **<scenario name>-SimGEN options** will overwrite options set using the ***Options*** menu
- SimGEN uses individual filenames to store **SimGEN options**, see the figure below:




Select one, or more, **SimGEN options** by clicking in its check box. You can save the options file using SimGEN's default filename or create a name of your choice. The figure above shows the default filenames after two of the options. A tick in the checkbox shows the scenario will use the settings in that file. Double-click the filename to open the relevant dialog and then select the parameters you want to use. Click **OK** to close the dialog. You can save the new settings to a new filename or overwrite the existing file.

Spirent recommends you do not overwrite default file names, but save new settings to a name of your choice.

The following table shows the items in **<scenario name>-SimGEN options**:

| **<scenario name>-SimGEN Options** |
|---|
| ***Bulk logging options*** |
| ***General options*** |
| ***Message reporting options*** |
| ***RS232 port options*** |
| ***User action options*** |

Notice that:

- Options you set using **<scenario name>-SimGEN Options** apply to **<scenario name>** only
- The options you set using **<scenario name>-SimGEN options** overwrite the options you set using the ***Options*** menu.

## 7.1 Bulk logging options

**Options-*Bulk logging options*** (page 5-1) details these options.

The **Bulk logging options file** uses the extension **.opt_bulk*.

## 7.2 General options

**Options-*General Options*** (page 5-15) details these options.

The **General options file** uses the extension **.opt_gen*.


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## 7.3 Message reporting options

**Options-*Message Reporting*** (page 5-26) details these options.

The **Bulk logging options file** uses the extension **.opt_bulk*.

## 7.4 RS232 port options

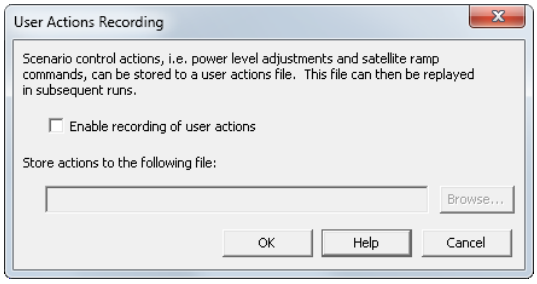
**Options-*RS-232 port settings*** (page 5-28) details these options.

The **RS232 port options file** uses the extension **. opt_rs232*.

## 7.5 User action options

***Note***: *The user action options file (extension *.opt_uact) overwrites the options set in* ***Options-User Actions Recording*** *(page 5-30)*

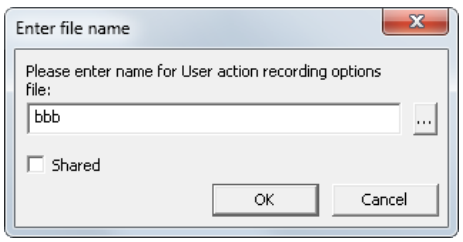
Double-click **User action options file** to open this dialog:



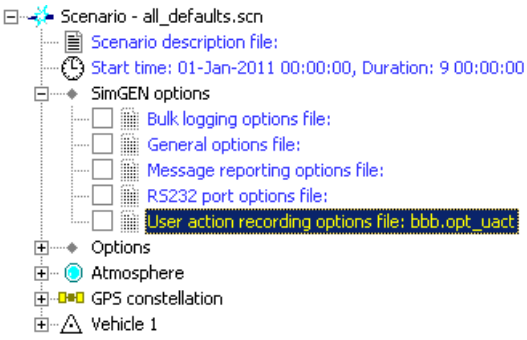

Notice if you have previously used menu item **Options-*User Actions Recording*** *(page 5-30)* for <**scenario name**>, this dialog automatically selects **Enable recording of user actions** and enters the name of the **.act* file. Click **Browse** to use a different filename or navigate to an alternative folder.

Select **Enable recording of user actions**, then click **Browse…** and navigate to the folder where you want to store the **User action options file**. **Menus-*Saving User Actions to a file*** (page 5-30) details a similar process for the user actions file (**.act*).

Clicking **OK** opens the **Enter file name** dialog:




Clicking **OK** applies the filename to the user actions recording options file for <**scenario name**> as shown below:





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The **User action recording options file** uses the extension **.opt_uact* - it overwrites any 'global' scenario settings from menu item **Options-*User Actions Recording*** (page 5-30) for <**scenario name**> only.


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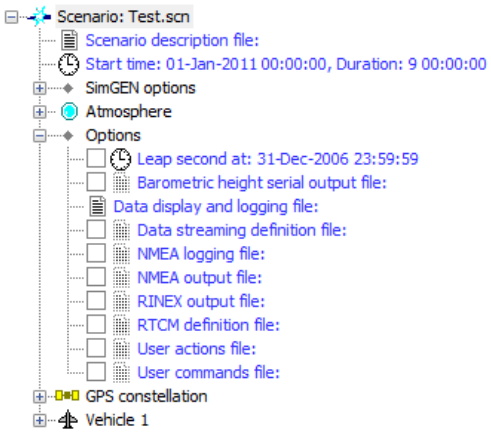
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# 8 Options

This chapter details options available for <**scenario name**> - the specific scenario you are editing in SimGEN. Changes you make in <**scenario name**>**-Options** will only affect <**scenario name**> and will not apply to SimGEN in general.

This figure shows the expanded <**scenario name**>**-Options**:




The following table shows the items in <**scenario name**>**-Options**:

| **<scenario name>-Options** |
|---|
| ***Leap second*** (page 8-1) |
| ***Barometric height serial output file*** (page 8-2) |
| ***Data display and logging file*** (page 8-3) |
| ***Data streaming definition file*** (page 8-6) |
| ***NMEA*** (page 8-9) |
| ***RINEX output file (observation file)*** (page 8-18) |
| ***RTCM definition file*** (page 8-22) |
| ***User Actions file, *.act*** (page 8-38) |
| ***User Commands file*** (page 8-39) |
| WiFi definition file - see reference iii) |

Notice that:

- → Options you set using <**scenario name**>**-Options** apply to all scenarios you run with SimGEN
- → SimGEN uses the optional ***RF cable delay and loss file*** to enter delay and loss values for the RF cables connecting the signal generator to the receiver

## 8.1 Leap second

***Notes:***

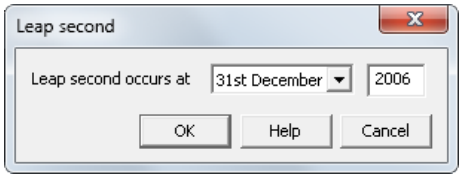
***1)*** *You must set the scenario start time so the leap second occurs during the scenario*

***2)*** *A GLONASS leap second event affects the GLONASS signal - see reference ll). Other constellations support leap second events with no change to their signals.*

Use to specify a time (June 30th or December 31st) when a leap second is to occur. If this is relevant to the current scenario time, the GNSS constellation will give advance warning of the timing of this event. GLONASS uses the

"KP" flag for this purpose. Notice this only affects timing of GLONASS signals if the scenario transits the time at which the leap second occurs.

You can choose the date of the leap second, either 31st December or 30th June:




Background information on leap second.

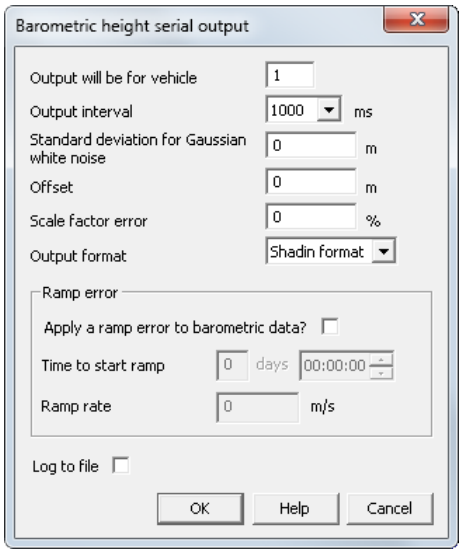
Leap second events are not specific to any GNSS system. Leap second events relate to adjustments of UTC (which defines the standard time of day) to ensure UTC remains appropriately aligned with the solar day (as determined by the Earth's rotation). The SI definition of a second is in terms of a caesium atomic clock and UTC time is aligned with this atomic time (TAI) apart from the introduction of leap seconds (typically every year or two). During 2011 the difference between these two time scales is 34 seconds.

GPS time (like TAI) is continuous and has no leap seconds; so, in this context, there is no leap second event. However, GPS navigation data messages do broadcast information relating to forthcoming (or recent) leap second occurrences (and other related corrections) to allow correct determination of UTC time from GPS time. This is the case for most other GNSS systems. However, GLONASS does implement leap seconds, which means the GLONASS signal timing shifts by one second, which introduces some discontinuity into the GLONASS navigation data messages.

## 8.2 Barometric height serial output file

***Note***: *SimGEN can only open COM ports up to and including COM9.*

SimGEN emulates barometric height by taking the height of the vehicle's centre of gravity and then adding one or more user-configurable errors. Enable by selecting **Options-Barometric height serial output file**:




You can log the data to file, or transmit the data over RS232. For details of further Barometric altimeter emulation (with data delivery over a MIL-STD 1553 interface), see ***INS error models*** (page 22-1) and reference rr).

The model uses these parameters:

| | | | |
|---|---|---|---|
| **Output will be for vehicle** | Specify which vehicle will use the data output port | | |
| | Units: none | Range: 0 to 99 | Default: 1 |
| ***Note**: You can use only one RS-232 port for altitude data* | | | |
| **Output interval** | The time between two consecutive barometric readings<br>Choose between **100 ms** or **1000 ms** | | |



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| | | | |
|---|---|---|---|
| **Standard deviation for Gaussian white noise** | Adds white noise to the GPS height, a standard deviation of zero adds no white noise to the height.<br>The additional height for each reading is from a Gaussian distribution using the GPS height as the mean value and this standard deviation. | | |
| | Units: metres | Range: 0 to 1 000 m | Default: 0 |
| **Offset** | Adds a constant bias to the barometric altitude | | |
| | Units: metres | Range: ±1 000 000 m | Default: 0 |
| **Scale Factor Error** | A measure of how barometric altitude error increases with height | | |
| | Units: percent | Range: ±1 % | Default: 0 |
| **Output format** | Choose from: | | |
| **Shadin format** | (default) a 17-byte message of the form:<br><br>RMS<sp><+/->12345T<+/->12ul<CR><br><br>where:<br>RMS ASCII characters<br><sp> space<br><+/-> sign indicator (+ or -)<br>12345 altitude, in feet ( 1 foot = 0.3048 m)<br>T ASCII character<br><+/-> sign indicator (+ or -)<br>12 temperature in Fahrenheit, see Note below<br>ul checksum of bytes 1 to 14 in hexadecimal<br><CR> carriage return | | |
| ***Note**: SimGEN does not model temperature.*<br>*T will always be -99, which indicates an invalid or unknown temperature.* | | | |
| **TOW and alt** | Time of week (seconds) followed by altitude (metres)<br>For example: 179220.0 355.54<CR><LF> | | |
| **Altitude only** | Altitude (metres)<br>For example: 355.54<CR><LF> | | |
| **Ramp error** | | | |
| **Apply a ramp error to barometric data?** | Deselect (default): no ramp error to the barometric data<br>Select: adds a ramp error to the barometric data | | |
| **Time to start ramp (from scenario start time)** | Units:<br>d hh:mm:ss | Range:<br>0 days 00:00:00<br>to 23 days 23:59:59 | Default:<br>0 days 00:00:00 |
| **Ramp rate** | Units: metres per second | Range: ±1 000 $m.s^{-1}$ | Default: 0 |
| **Log to file** | Deselect (default): does not write barometric altitude to a file<br>Select: writes barometric altitude to the file *Baro_log.csv*, located in the current scenario folder.<br>The data format of *Baro_log.csv* is time, altitude in metres. | | |

## 8.3 Data display and logging file

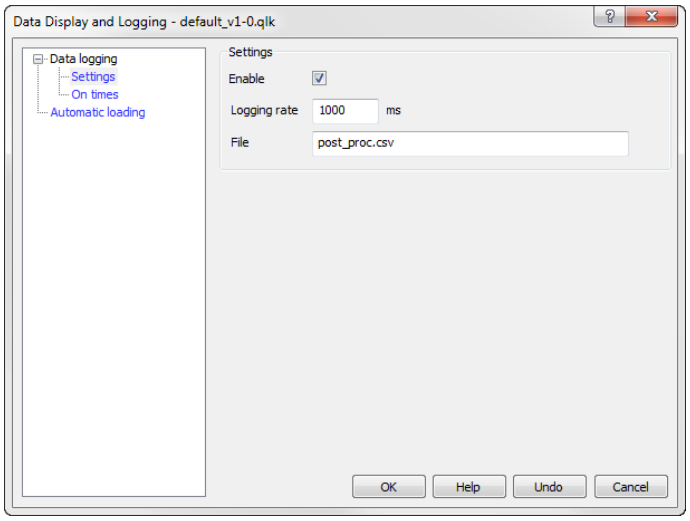
***Note**: From SimGEN version 2-83 onward, you must connect a valid Spirent signal generator to the SimGEN Controller, or install a "no hardware" licence, to enable data logging to a file when you run any scenario in* **No hardware ("dummy run")** *mode*.

The following sections detail how you enable data logging and set up the method of logging.


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### 8.3.1 Data logging - Settings

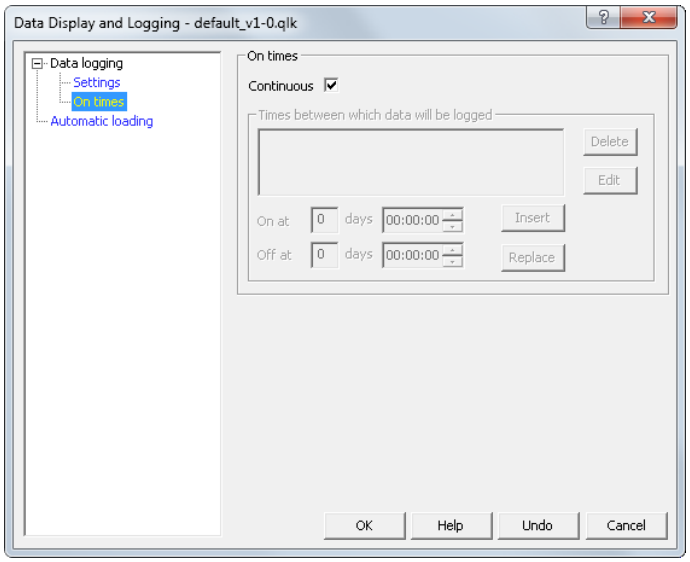
The figure below shows the dialog.




| | | | |
|---|---|---|---|
| **Enable** | Deselect (default): does not log data<br>Select: logs data to the **File** and at the **Logging rate** you specify | | |
| **Logging rate** | You must select a multiple of the **Simulation iteration rate** you selected in the menu item **Options-*General Options*** (page 5-15)<br>For example, using a Simulation Iteration Rate of 10 milliseconds the maximum logging rate is 10 milliseconds, but other valid rates are 20, 30, 40 milliseconds and so on. | | |
| | Units: milliseconds | Range: 1 to 1 000 000 ms | Default: 1 000 |
| **File** | Writes logged data to the file *post_proc.csv*, located in the current scenario folder. | | |

### 8.3.2 Data logging - On times

This allows logging of large amounts of data at a high-rate, so conserving disk space. The default is **Continuous** logging, or deselect **Continuous** and enter the on and off days and times of day at which you want the data logged:




| | | | |
|---|---|---|---|
| **Continuous** | Select (default): logs data continuously<br>Deselect: enables **On** and **Off** times to select times to log data | | |
| **Off at**<br>**On at** | Units:<br>days hh:mm:ss | Range: 0 00:00:00<br>to 23 23:59:59 | Default:<br>0 days 00:00:00 |



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Type the **On** time and **Off** time click **Insert**. The times appear in the **Off times** area. There is no limit to the number of **On** and **Off** times.

Select a time in the **Off times** area and click **Edit** to edit the **On** / **Off** times.

Select a time in the **Off times** area and click **Replace** to replace these times with the times currently in the **Off at** and **On at** text boxes.

Select a time in the **Off times** area and click **Delete** to delete these **On** / **Off** times.

Click **All** to apply the times in the **Off times** area to all **Satellites**. A tick next to the **All** button confirms this action.

## 8.3.3 Automatic loading

***Note**: C50r SimGEN Host users see **3)** C50r SimGEN Host users see **Important details for all users of the C50r SimGEN Host** (page 1-8)*

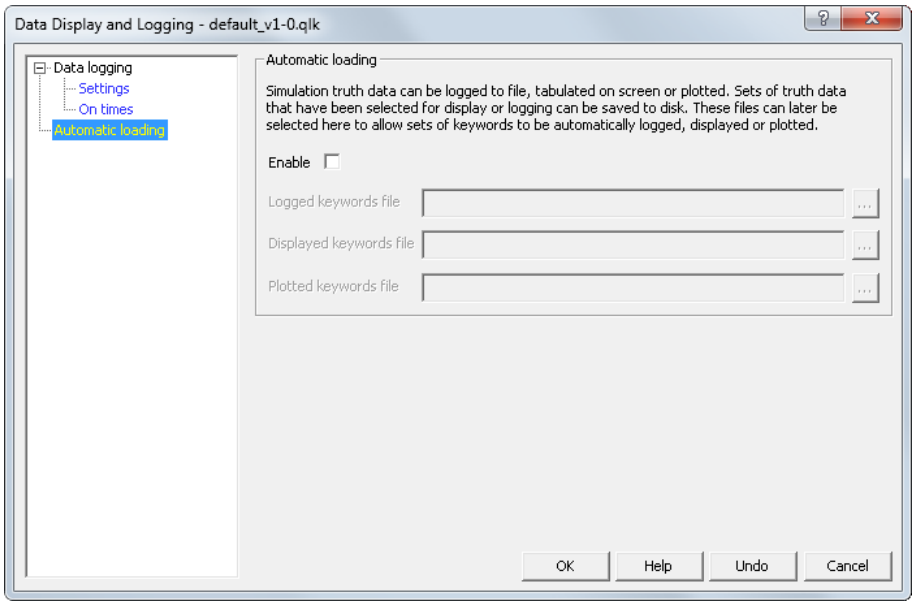
You can save the items to log (and display and plot) using keyword files, which are files with these extensions:

- **.qll* (quick look logged)
- **.qld* (quick look display)
- **.qlp* (quick look plot)

By default, SimGEN saves these files in the current scenario folder.

Using these Quick-Look files means SimGEN will log, display and plot the same data every time you run that scenario.

To use this, double-click **Data display and logging file**, see below:




Select **Automatic loading**.

Select **Enable** to store the three **Keywords files** with the scenario for re-use. Click on the **...** button to navigate to the folder where you want to store each of the **Keyword files** (the default folder is the current scenario folder).

### 8.3.3.1 Logged data file format

SimGEN stores logged data in an ASCII text file. Below is a fragment of an example file:

```
Label: post_proc.txt Scenario_start_time: 01-Jan-2002 01:00:00
time,v1_a1GPS5mp0P_RANGE,v1_a1GPS5mp0PR_RATE,v1_a1GPSTX5mp0SIG_ELEV,v1_a1GPSTX5mp0SIG
_AZIM
0.100,21096493.5,380.52,0.955286,2.519210
0.200,21096531.5,380.53,0.955273,2.519222
0.300,21096569.6,380.54,0.955260,2.519234
0.400,21096607.6,380.55,0.955247,2.519246
0.500,21096645.7,380.56,0.955234,2.519258
0.600,21096683.7,380.57,0.955221,2.519270
0.700,21096721.8,380.58,0.955208,2.519282
```


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```
0.800,21096759.8,380.59,0.955196,2.519294
0.900,21096797.9,380.60,0.955183,2.519305
```

**Line 1** identifies the filename and the scenario start-time. Rows of data are time-stamped with time-into-run, so the start time allows conversion of the timestamps to a date and time, or GPS TOW.

**Line 2** defines the comma-separated data items in each following line. The labels uniquely identify the data item.

**Line 3** onward in the example file:

| | |
|---|---|
| `time` | time into run (seconds)<br>`0.100` |
| `v1_a1GPS5mp0P_RANGE` | Vehicle 1, Antenna 1, GPS satellite SVID5, multipath0, PSEUDORANGE.<br>Here, multipath0 is the normal or incident GPS signal. Multipath signals would be designated mp1, mp2, ....<br>`21096493.5` |
| `v1_a1GPS5mp0PR_RATE` | Vehicle 1, Antenna 1, GPS satellite SVID5, multipath0, PSEUDORANGE RATE.<br>Here, multipath0 is the normal or incident GPS signal. Multipath signals would be designated mp1, mp2, ....<br>`380.52` |
| `v1_a1GPSTX5mp0SIG_ELEV` | Vehicle 1, Antenna 1, GPS satellite SVID5, multipath0, SIGNAL ELEVATION.<br>Here, multipath0 is the normal or incident GPS signal. Multipath signals would be designated mp1, mp2, ....<br>`0.955286` |
| `v1_a1GPSTX5mp0SIG_AZIM` | Vehicle 1, Antenna 1, GPS satellite SVID5, multipath0, SIGNAL AZIMUTH.<br>Here, multipath0 is the normal or incident GPS signal. Multipath signals would be designated mp1, mp2, ....<br>`2.519210` |

You can import the comma-separated variable (**.csv*) format into many popular spreadsheet and mathematical programs for further manipulation, processing and printing.

## 8.4 Data streaming definition file

***Notes**:*

***1)** The Data Streaming facility supersedes the STR4761 Real-Time Ethernet upgrade package supported in SimGEN for VMS. Reference qq) gives more details on Data Streaming.*

***2) Legacy Nav**, **M Nav** and **Alma & Ephem** are licenced features. Reference qq) gives details.*

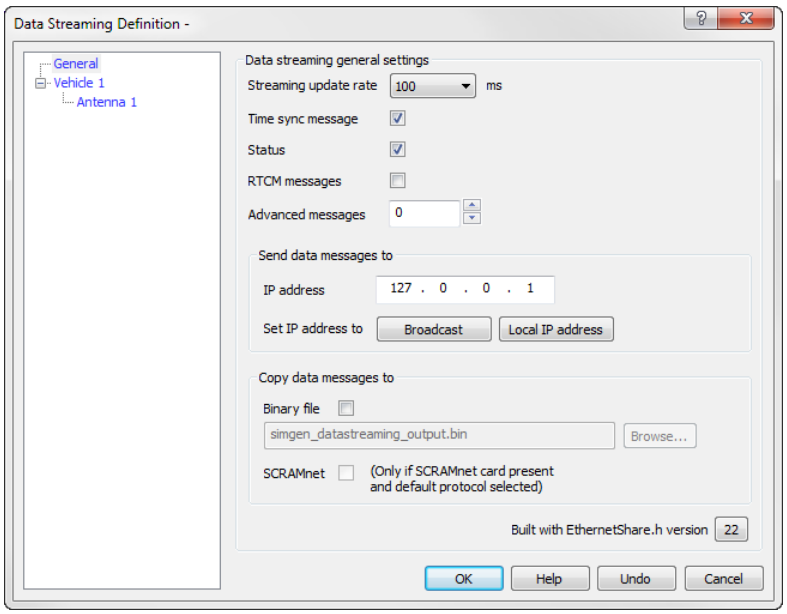
***3)** The C50r SimGEN Host only supports SCRAMnet GT200*

Data Streaming in SimGEN lets you stream data over Ethernet using the UDP/IP transport protocol. You control where it sends data, how fast it sends data and what data it sends.

The figure below shows the **Data Streaming** dialog when using a C50r SimGEN Host:



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| | |
|---|---|
| **Streaming update rate** | Choose from 4, 5, 8, 10, 20, 40, 50, 100 (default), 500, 1 000 milliseconds |
| **Time sync message** | Select (default): While a scenario is running, SimGEN sends a time sync message datagram at one-second intervals, starting at zero seconds into run. It helps a remote system synchronise to SimGEN's time.<br>Deselect: SimGEN does not send a time sync message. |
| ***Note**: Spirent advises you use the time sync message as a close approximation of the current time. This message can be late due to overheads from: processing, transmission of the UDP datagram and reading and interpreting the datagram.* | |
| **Status** | Select (default): Sends a status message datagram whenever the status of SimGEN changes, such as changing state from READY to ARMING.<br>The status datagram also contains the time step SimGEN is using (between 10 and 100 ms).<br>If you select the truth aiding EGI message, SimGEN automatically selects **Status**<br>Deselect: SimGEN does not send a status message. |
| **RTCM Messages** | Deselect: Does not send RTCM messages<br>Select: Sends RTCM Messages over IP using Datastreaming |

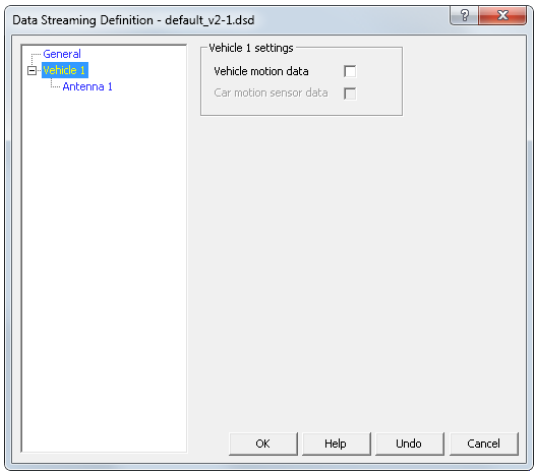

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| | | | |
|---|---|---|---|
| **Advanced messages** | Sends Data Streaming in advance of the current scenario time (both during Arming and during the scenario) using a multiple of the **Simulation Iteration Rate** see ***General Options*** (page 5-15).<br>**Advanced messages** sets the number of messages SimGEN broadcasts in advance. For example, using a **Simulation Iteration Rate** of 10 milliseconds and **Advanced messages-2**:<br>During Arming, at t = 0 milliseconds, SimGEN will broadcast data relating to t = 0, t = 10 and t= 20 milliseconds<br>(SimGEN broadcasts two messages in advance of t = 0)<br>Subsequently, during the run, SimGEN will broadcast date two messages in advance, so at t = 10 milliseconds SimGEN broadcasts data relating to t = 30 milliseconds and so on.<br>(SimGEN does not repeat messages, so at t = 10 milliseconds it does not repeat the message for t = 20 milliseconds)<br><br>Using **Advanced messages** relies on running the simulation ahead of when SimGEN needs to send data to the signal generator. This requires advanced knowledge of the vehicle trajectory and Spirent recommends you do not use **Advanced messages** if you use remote commands or remote motion, especially in “real-time”.<br>The maximum number of **Advanced messages** is related to the **Simulation Iteration Rate**. As you cannot stream data in advance by more than one second, this means the maximum number of **Advanced messages** is variable.<br>SimGEN will produce a fatal error if you use a number of **Advanced messages** that will give more than one second’s worth of advanced data streaming. For example, using **Advanced messages-50** with a **Simulation Iteration Rate** of 100 milliseconds will attempt to send 50 messages at 100 millisecond intervals. | | |
| | Units: none | Range: 0 to 1 000 (integer and see above) | Default: 0 |
| **Send data messages to** | | | |
| **IP address** | Type the IP address for UDP messages<br>Click to set the default IP address as follows:<br>**Broadcast** : 255.255.255.255<br>**Local IP Address**: 127.0.0.1<br>This button is also visible when using a C50r SimGEN Host:<br>**Windows VM** 192.168.25.1 | | |
| ***Notes for using RTCM Messages**: You canot decode the output binary data streaming file, <…/scenario_name>/simgen_datastreaming_output.bin, using **RTCM Decoder** (page 26-51) as the data in this file is split into individual messages, rather than a single data dump of all messages.*<br>*To decode the output binary data streaming file Spirent recommends you generate the file <…/scenario_name>/rtcm_nav_dump.bin, before running your scenario. You can then use **RTCM Decoder** to decode the file <…/scenario_name>/rtcm_nav_dump.bin.*<br>*To do this, select:*<br>***General utilities-Data Streaming Message Logger** (page 26-32)-RTCM Messages*<br>***Options-General options** (page 7-1)-Dump navigation data*<br>***Options- Data streaming definition file** (and select a filename)*<br>***Options-General-Data streaming definition file-General-Data streaming general settings-RTCM Messages***<br>***Options-General-Data streaming definition file-General-Copy data messages to-Binary file*** | | |
| **Copy data messages to** | | | |
| **Binary file** | Deselect (default): does not store a data message file<br>Select: stores the data message file as a binary file (*.bin) and enables text area<br><br>Click **Browse** and navigate to the folder where you want to store the data message file | | |
| **SCRAMnet** | Only enabled if your SimGEN Controller or C50r SimGEN Host has a suitable SCRAMNet+ (SimGEN Controller only) or SCRAMNet GT200 (SimGEN Controller and C50r SimGEN Host) card and you have installed the associated drivers.<br>Select to use SCRAMNet | | |


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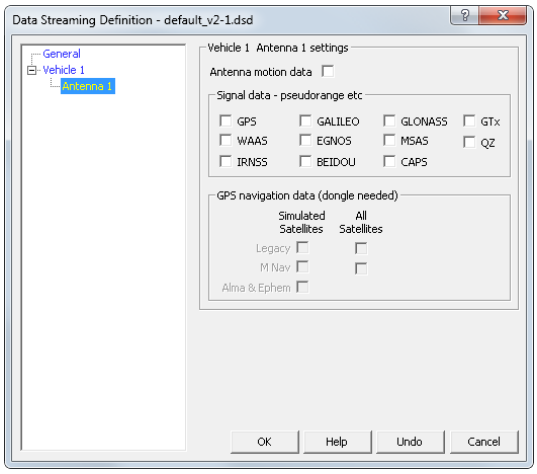
| | |
|---|---|
| **Built with Ethernetshare.h version** | Displays the version number |

This is the **Data Streaming Definition** dialog for **Vehicle 1**




Select **Vehicle motion data** to stream this data.

This is the **Data Streaming Definition** dialog for **Vehicle 1-Antenna 1**




Select **Antenna motion data** and the **Signal data-pseudorange** you want to use. Notice **GPS navigation data** requires a dongle to enable the checkboxes. Spirent only supplies dongles to authorised users.

## 8.5 NMEA logging

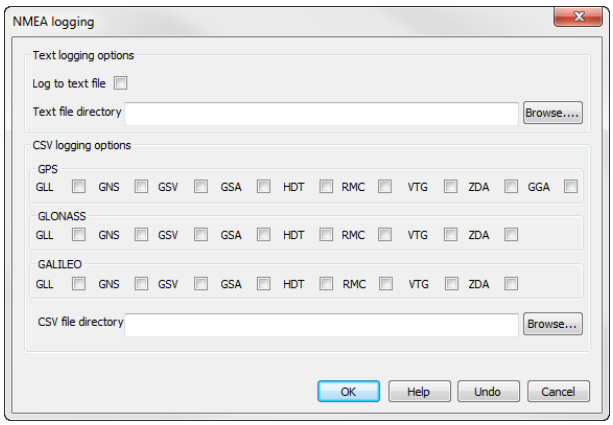
***Notes**:*

***1)** SimGEN can only open COM ports up to and including COM9.*

***2)** SimGEN version 5.03 onwards supports NMEA 0183 version 4.10, reference dddd)*

***3)** C50r SimGEN Host users see **Important details for all users of the C50r SimGEN Host** (page 1-8)*

To log NMEA messages from an external source, first select the correct COM port settings (see the menu item **Options-*RS-232 port settings*** (page 5-28)), then select **NMEA logging** in the **Scenario window**. This creates the default logging file *default_vx-yy.nmea_in*. Double-click this file in the **Scenario contents** window to edit the **NMEA Input** dialog see the figure below:




You can log NMEA messages, as raw NMEA, to a text file; or separate messages may be decoded and written to a **.csv* file. By default, SimGEN writes all files to the current scenario folder. You can specify an alternative folder by clicking **Browse** and navigating to that folder.

You can view NMEA messages produced during a scenario by clicking on the NMEA scenario toolbar button.

### 8.5.1 Displaying receiver errors using SimGEN

Using SimGEN's **Quick look** menu (see ***Accessing simulation (Quick-Look) data*** (page 25-1)) select the **UUT** keyword set, then select **Rx plan error** or **Rx spherical error**, so you can log, plot or view incoming NMEA data while the receiver is navigating. You must enable the GGA message (GPS only) or GNS message (GPS/GLONASS), or your receiver must output the GGA message and/or the GNS message, before SimGEN can calculate the receiver plan error (2-D) and/or the receiver spherical error (3-D). Connect the receiver to the SimGEN Controller using an RS-232 serial cable and enable the appropriate COM port. This facility is also available using the offline NMEA logging utility see **SimGEN utilities-*NMEA Logging*** (page 26-48).

This table gives the equations SimGEN uses to calculate Spherical errors:

| Error | Equation |
|---|---|
| Spherical Error<br>(ECEF co-ordinates) | $\sqrt{((R_x - S_x)^2 + (R_y - S_y)^2 + (R_z - S_z)^2)}$ |
| Spherical Error<br>(North,East,Down co-ordinates) | $\sqrt{(del_N^2 + del_E^2 + del_D^2)}$ |
| Plan Error<br>(projection of Spherical Error onto North, East plane) | $\sqrt{( del_N^2 + del_E^2)}$ |
| Plan Error<br>(as a function of the Spherical Error) | $\sqrt{( (Spherical\ Error)^2 - del_D^2)}$ |

Where:

$R_x$: X co-ordinate of the receiver, ECEF co-ordinates

$R_y$: Y co-ordinate of the receiver, ECEF co-ordinates

$R_z$: Z co-ordinate of the receiver, ECEF co-ordinates

$S_x$: X co-ordinate of the simulated position, ECEF co-ordinates

$S_y$: Y co-ordinate of the simulated position, ECEF co-ordinates

$S_z$: Z co-ordinate of the simulated position, ECEF co-ordinates

del_N: North co-ordinate of the Spherical Error, in the local frame

del_E: East co-ordinate of the Spherical Error, in the local frame

del_D: Down co-ordinate of the Spherical Error, in the local frame.
del_D is also the inverse of the height error and equal to (Simulated_Height - Receiver_Height)


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## 8.6 NMEA output

***Note**:*

***1)** From SimGEN version 2-83 onward, you must connect a valid Spirent signal generator to the SimGEN Controller, or install a "no hardware" licence, to enable data logging to a file when you run any scenario in **No hardware ("dummy run")** mode.*

***2)** The only Spirent implemented difference between NMEA 01803 Version 2.20 and version 3.01 is an extra field appended to the GLL, RMC and VTG message types.*

***3)** You can log any combination of GPS, GLONASS and Galileo NMEA messages as long as your scenario uses satellites in these constellations.*

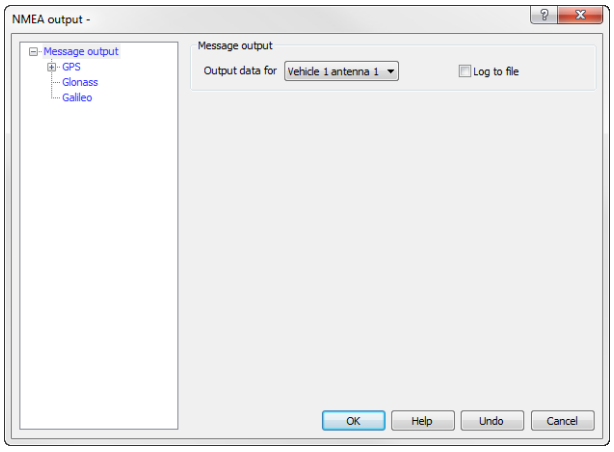
***4)** The GSV message shows visible satellites. The latest NMEA 0183 interface standard, reference dddd), allocates a System ID to each constellation and then allocates Satellite ID numbers to satellite channels, Table 21 in reference dddd) gives more details.*
*SimGEN does not output NMEA data for GPS SBAS satellites, SimGEN uses System ID 1, with Satellite ID in the range 33 to 64 for GPS extended satellites.*

***5)** C50r SimGEN Host users see **Important details for all users of the C50r SimGEN Host** (page 1-8)*

***6)** There is a limit on how many messages you can send over RS-232. The limit depends on your setting for baud rate in **SimGEN options-RS-232 port settings** (page 5-28). For example, if you set every message type to update at 100 milliseconds intervals and set baud rate to 4 800 you will likely see NMEA output data lagging behind the run time.*

This dialog lets you output simulation data from GPS, GLONASS or Galileo satellites as NMEA data messages, in steps of up to one-hundred millisecond intervals, with a minimum of one-hundred milliseconds. You can use the NMEA data for comparison against the position a receiver indicates. SimGEN sends the NMEA data to a COM port and/or a text file. Select the RS232 options you want to use from **Options-RS232 Port Setting** and set it up in the same way as for RTCM, see ***RTCM definition file*** (page 8-22).

Select <**scenario name**>**-Options-NMEA output file** to enable this option (ensure there is a tick in the check box) and to create the default file *default_vx-yy.nmea.* Double-click to set up the NMEA outputs you want to use using this dialog:

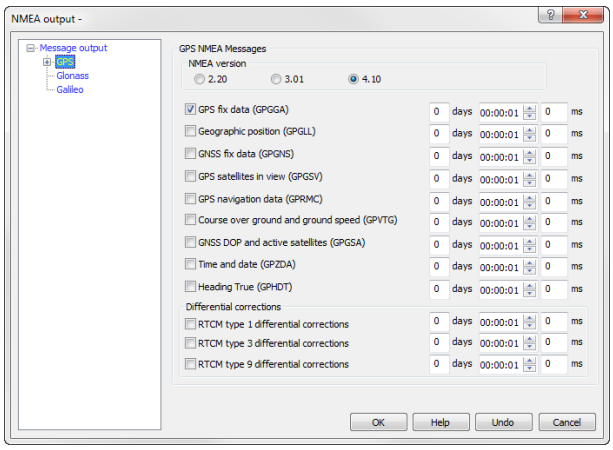



Select **Output data for** vehicle 'number'_antenna 'number'.

Select **Log to file** to record both GPS, GLONASS and Galileo NMEA messages in the file *nmea.txt*. SimGEN sends this file, which is located in the current scenario folder, to the COM port.

### 8.6.1 GPS

This figure shows the GPS dialog.




For GPS, SimGEN currently supports NMEA versions 2.20, 3.01 and 4.10.

Select each **GPS NMEA message** and **Differential correction** you want to output, together with the Output interval in **days** and **hh:mm:ss ms**. The default interval in each case is one second.

The following sections give examples of the GPS NMEA message and Differential correction output files.

These GPS example messages use NMEA version 4.10 and were recorded at the same time as the ***GLONASS*** (page 8-14) and ***Galileo*** (page 8-16) messages.

### 8.6.1.1 GPS fix data (GPGGA)

***Note**: The GGA message is only available for GPS satellites*

```
$GPGGA,000000,5025.50000,N,00335.75000,W,3,09,0.89,47.98,M,52.02,M,,*5D
$GPGGA,000001,5025.50248,N,00335.70809,W,3,09,0.89,47.99,M,52.01,M,,*54
$GPGGA,000002,5025.51270,N,00335.66919,W,3,09,0.89,47.99,M,52.01,M,,*5A
$GPGGA,000003,5025.52993,N,00335.63693,W,3,09,0.89,47.99,M,52.01,M,,*56
$GPGGA,000004,5025.55257,N,00335.61429,W,3,09,0.89,47.99,M,52.01,M,,*54
$GPGGA,000005,5025.57851,N,00335.60339,W,3,09,0.89,47.99,M,52.01,M,,*5C
```

### 8.6.1.2 Geographic position (GPGLL)

```
$GPGLL,5025.50000,N,00335.75000,W,000000,A*38
$GPGLL,5025.50248,N,00335.70809,W,000001,A*33
$GPGLL,5025.51270,N,00335.66919,W,000002,A*3D
$GPGLL,5025.52993,N,00335.63693,W,000003,A*31
$GPGLL,5025.55257,N,00335.61429,W,000004,A*33
$GPGLL,5025.57851,N,00335.60339,W,000005,A*3B
```

### 8.6.1.3 GNSS fix data (GPGNS)

(This message is similar to the GGA message)

```
$GPGNS,000000,5025.50000,N,00335.75000,W,,AN,A,09,,47.98,52.02,,,V*5E
$GPGNS,000001,5025.50248,N,00335.70809,W,,AN,A,09,,47.99,52.01,,,V*57
$GPGNS,000002,5025.51270,N,00335.66919,W,,AN,A,09,,47.99,52.01,,,V*59
$GPGNS,000003,5025.52993,N,00335.63693,W,,AN,A,09,,47.99,52.01,,,V*55
$GPGNS,000004,5025.55257,N,00335.61429,W,,AN,A,09,,47.99,52.01,,,V*57
$GPGNS,000005,5025.57851,N,00335.60339,W,,AN,A,09,,47.99,52.01,,,V*5F
```

### 8.6.1.4 GPS satellites in view (GPGSV)

```
$GPGSV,9,1,9,9,51,241,62,10,12,162,60,15,77,97,62,18,43,299,61,1*5F
$GPGSV,9,1,9,9,51,241,62,10,12,162,60,15,77,97,62,18,43,299,61,1*5F
$GPGSV,9,1,9,9,51,241,62,10,12,162,60,15,77,97,62,18,43,299,61,1*5F
$GPGSV,9,1,9,9,51,241,62,10,12,162,60,15,77,97,62,18,43,299,61,1*5F
$GPGSV,9,1,9,9,51,241,62,10,12,162,60,15,77,97,62,18,43,299,61,1*5F
$GPGSV,9,1,9,9,51,241,62,10,12,162,60,15,77,97,62,18,43,299,61,1*5F
```

### 8.6.1.5 GPS navigation data (GPRMC)

With the recommended minimum specific GPS/TRANSIT Data (NMEA version 2-20)

```
$GPRMC,000000,A,5025.50000,N,00335.75000,W,97.191,90.000,010111,0.000,E,A,V*7D
$GPRMC,000001,A,5025.50248,N,00335.70809,W,97.191,76.421,010111,0.000,E,A,V*79
$GPRMC,000002,A,5025.51270,N,00335.66919,W,97.191,58.879,010111,0.000,E,A,V*7A
$GPRMC,000003,A,5025.52993,N,00335.63693,W,97.191,41.337,010111,0.000,E,A,V*7F
$GPRMC,000004,A,5025.55257,N,00335.61429,W,97.191,23.795,010111,0.000,E,A,V*75
$GPRMC,000005,A,5025.57851,N,00335.60339,W,97.191,6.253,010111,0.000,E,A,V*45
```


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#### 8.6.1.6 Course over ground and ground speed (GPVTG)

```
$GPVTG,23.795,T,23.795,M,97.191,N,179.997,K*71
$GPVTG,297.813,T,297.813,M,97.191,N,179.997,K*71
$GPVTG,316.210,T,316.210,M,97.191,N,179.997,K*71
$GPVTG,334.607,T,334.607,M,97.191,N,179.997,K*71
$GPVTG,353.005,T,353.005,M,97.191,N,179.997,K*71
$GPVTG,356.180,T,356.180,M,97.191,N,179.997,K*71
```

#### 8.6.1.7 GNSS DOP and active satellites (GPGSA)

```
$GPGSA,A,3,09,10,15,18,21,22,26,27,28,,,,1.6,0.9,1.3,1*2E
$GPGSA,A,3,09,10,15,18,21,22,26,27,28,,,,1.6,0.9,1.3,1*2E
$GPGSA,A,3,09,10,15,18,21,22,26,27,28,,,,1.6,0.9,1.3,1*2E
$GPGSA,A,3,09,10,15,18,21,22,26,27,28,,,,1.6,0.9,1.3,1*2E
$GPGSA,A,3,09,10,15,18,21,22,26,27,28,,,,1.6,0.9,1.3,1*2E
$GPGSA,A,3,09,10,15,18,21,22,26,27,28,,,,1.6,0.9,1.3,1*2E
```

#### 8.6.1.8 Time and date (GPZDA)

Spirent assumes a simple time zone offset of one hour per 15 degrees longitude.

```
$GPZDA,000000.00,01,01,2011,00,00*64
$GPZDA,000001.00,01,01,2011,00,00*65
$GPZDA,000002.00,01,01,2011,00,00*66
$GPZDA,000003.00,01,01,2011,00,00*67
$GPZDA,000004.00,01,01,2011,00,00*60
$GPZDA,000005.00,01,01,2011,00,00*61
```

#### 8.6.1.9 Heading True (GPHDT)

```
$GPHDT,297.813,T*33
$GPHDT,316.210,T*32
$GPHDT,334.607,T*30
$GPHDT,353.005,T*35
$GPHDT,356.180,T*3C
$GPHDT,356.180,T*3C
```

#### 8.6.1.10 RTCM differential corrections (GPMSG)

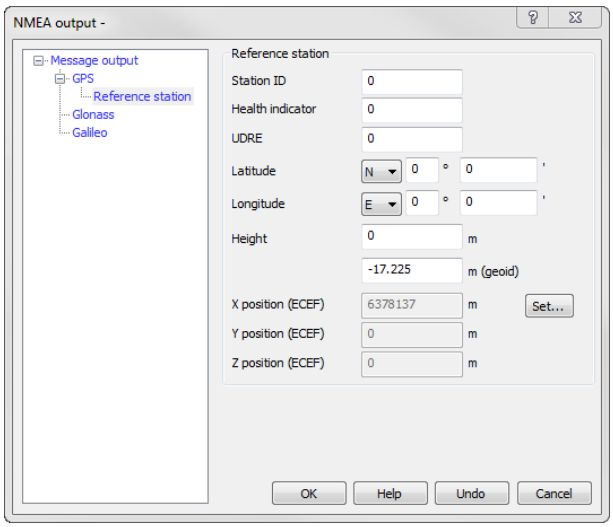
You can select types 1, 3 and 9 RTCM differential corrections for generation in NMEA format.

```
$GPMSG,01,0000,0000.0,0,0,24,000000.00,0,02,-0011.67,+0.000,000*7C
$GPMSG,01,0000,0000.0,1,0,24,000000.00,0,05,-0005.52,+0.000,000*79
$GPMSG,01,0000,0000.0,2,0,24,000000.00,0,09,-0006.89,+0.000,000*73
$GPMSG,01,0000,0000.0,3,0,24,000000.00,0,10,-0004.29,+0.000,000*72
$GPMSG,01,0000,0000.0,4,0,24,000000.00,0,12,-0004.72,+0.000,000*79
$GPMSG,01,0000,0000.0,5,0,24,000000.00,0,15,-0007.83,+0.000,000*72
$GPMSG,01,0000,0000.0,6,0,24,000000.00,0,21,-0017.88,+0.000,000*7C
$GPMSG,01,0000,0000.0,7,0,24,000000.00,0,24,-0006.92,+0.000,000*73
$GPMSG,01,0000,0000.0,8,0,24,000000.00,0,26,-0007.69,+0.000,000*7B
$GPMSG,01,0000,0000.0,9,0,24,000000.00,0,30,-0010.65,+0.000,000*77
$GPMSG,03,0000,0000.0,0,0,35,000000.00,+6378137.00,+0000000.00,+0000000.00*41
$GPMSG,09,0000,0000.0,0,0,24,000000.00,0,02,-0011.67,+0.000,000*74
$GPMSG,09,0000,0000.0,1,0,24,000000.00,0,05,-0005.52,+0.000,000*71
$GPMSG,09,0000,0000.0,2,0,24,000000.00,0,09,-0006.89,+0.000,000*7B
$GPMSG,09,0000,0000.0,3,0,24,000000.00,0,10,-0004.29,+0.000,000*7A
```

#### 8.6.1.11 Reference station

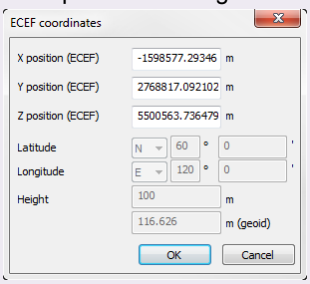
The data you enter in the **NMEA output-Reference station** dialog is independent of data in the **RTCM definition-Reference station**.


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Ensure you set the **Reference station** position to be in the same part of the world as the vehicle(s) receiving the corrections.

Enter the **Reference station** position using **Latitude**, **Longitude** and **Height** or click **Set** to use ECEF co-ordinates.

| | | | |
|---|---|---|---|
| **Station ID** | Units: none | Range: 0 to 1 023 | Default: 0 |
| **Health indicator** | The health of the reference station | Range: 0 to 7<br>Where:<br>7 - not working properly<br>6 - not monitored<br>0 to 6 are specified by the individual service provider and do not have a fixed meaning | Default: 0 |
| **UDRE** | Units: none | Range: 0 to 3 | Default: 0 |
| **Latitude** | Units: degrees, minutes | Range: N 90° 0’ to S 90° 0´ | |
| **Longitude** | Units: degrees, minutes | Range: E 180° 0.0´ to W 180° 0.0´ | |
| **Height** | Units: metres | Range: -9 999<br>to 30 000 m | Default: 0<br>(-18 for geoid) |
| Clicking **Set…** opens this dialog in which you can enter the reference location in **ECEF coordinates**:<br>  <br>Notice **Latitude**, **Longitude** and **Height** update automatically as you move between the X, Y and Z positions. | | | |
| **X position (ECEF)**<br>**Y position (ECEF)**<br>**Z position (ECEF)** | Units: metres | Range: -1E10 to 1E10 m | |

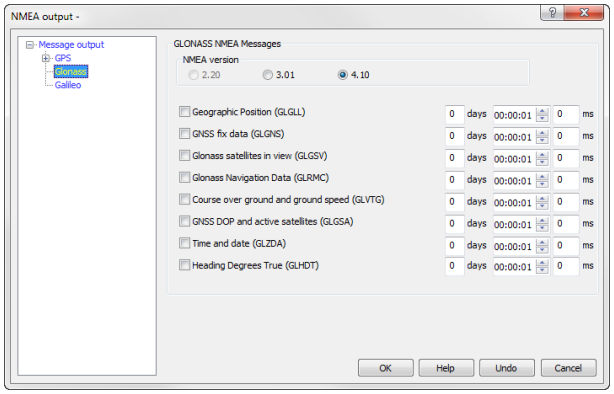


## 8.6.2 GLONASS

***Note**: To log GLONASS NMEA messages in nmea.txt and provide an NMEA output file containing GLONASS NMEA messages, your scenario must assign at least one antenna to the GLONASS constellation.*


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For GLONASS satellites, SimGEN currently supports NMEA versions 3.01 and 4.10. Use this dialog to select each message you want to output, together with the Output interval in **days** and **hh:mm:ss ms**. The default interval in each case is one second.




The following sections give examples of the GLONASS NMEA message output files. In the output file, GLONASS messages begin with '$GL' followed by the three-letter acronym of the message.

These GLONASS example messages use NMEA version 4.10 and were recorded at the same time as the ***GPS*** (page 8-11) and as the ***Galileo*** (page 8-16) messages.

#### 8.6.2.1 Geographic position (GLGLL)

```
$GLGLL,5025.50000,N,00335.75000,W,000000,A*24
$GLGLL,5025.50248,N,00335.70809,W,000001,A*2F
$GLGLL,5025.51270,N,00335.66919,W,000002,A*21
$GLGLL,5025.52993,N,00335.63693,W,000003,A*2D
$GLGLL,5025.55257,N,00335.61429,W,000004,A*2F
$GLGLL,5025.57851,N,00335.60339,W,000005,A*27
```

#### 8.6.2.2 Fix data (GLGNS)

```
$GLGNS,000000,5025.50000,N,00335.75000,W,,NA,A,08,,47.98,52.02,,,V*43
$GLGNS,000001,5025.50248,N,00335.70809,W,,NA,A,08,,47.99,52.01,,,V*4A
$GLGNS,000002,5025.51270,N,00335.66919,W,,NA,A,08,,47.99,52.01,,,V*44
$GLGNS,000003,5025.52993,N,00335.63693,W,,NA,A,08,,47.99,52.01,,,V*48
$GLGNS,000004,5025.55257,N,00335.61429,W,,NA,A,08,,47.99,52.01,,,V*4A
$GLGNS,000005,5025.57851,N,00335.60339,W,,NA,A,08,,47.99,52.01,,,V*42
```

#### 8.6.2.3 Satellites in view (GLGSV)

```
$GLGSV,4,1,8,66,32,200,61,67,53,286,62,68,25,328,61,75,13,66,60,1*7F
$GLGSV,4,1,8,66,32,200,61,67,53,286,62,68,25,328,61,75,13,66,60,1*7F
$GLGSV,4,1,8,66,32,200,61,67,53,286,62,68,25,328,61,75,13,66,60,1*7F
$GLGSV,4,1,8,66,32,200,61,67,53,286,62,68,25,328,61,75,13,66,60,1*7F
$GLGSV,4,1,8,66,32,200,61,67,53,286,62,68,25,328,61,75,13,66,60,1*7F
$GLGSV,4,1,8,66,32,200,61,67,53,286,62,68,25,328,61,75,13,66,60,1*7F
```

#### 8.6.2.4 Navigation data (GLRMC)

```
$GLRMC,000000,A,5025.50000,N,00335.75000,W,97.191,90.000,010111,0.000,E,A,V*61
$GLRMC,000001,A,5025.50248,N,00335.70809,W,97.191,76.421,010111,0.000,E,A,V*65
$GLRMC,000002,A,5025.51270,N,00335.66919,W,97.191,58.879,010111,0.000,E,A,V*66
$GLRMC,000003,A,5025.52993,N,00335.63693,W,97.191,41.337,010111,0.000,E,A,V*63
$GLRMC,000004,A,5025.55257,N,00335.61429,W,97.191,23.795,010111,0.000,E,A,V*69
$GLRMC,000005,A,5025.57851,N,00335.60339,W,97.191,6.253,010111,0.000,E,A,V*59
```

#### 8.6.2.5 Course over ground and ground speed (GLVTG)

```
$GLVTG,23.795,T,23.795,M,97.191,N,179.997,K*6D
$GLVTG,356.182,T,356.182,M,97.191,N,179.997,K*6D
$GLVTG,356.182,T,356.182,M,97.191,N,179.997,K*6D
$GLVTG,356.182,T,356.182,M,97.191,N,179.997,K*6D
$GLVTG,356.182,T,356.182,M,97.191,N,179.997,K*6D
$GLVTG,356.182,T,356.182,M,97.191,N,179.997,K*6D
```

#### 8.6.2.6 DOP and active satellites (GLGSA)

```
$GLGSA,A,3,66,67,68,75,77,84,85,86,,,,,2.6,1.1,2.4,3*31
$GLGSA,A,3,66,67,68,75,77,84,85,86,,,,,2.6,1.1,2.4,3*31
$GLGSA,A,3,66,67,68,75,77,84,85,86,,,,,2.6,1.1,2.4,3*31
```

```
$GLGSA,A,3,66,67,68,75,77,84,85,86,,,,,2.6,1.1,2.4,3*31
$GLGSA,A,3,66,67,68,75,77,84,85,86,,,,,2.6,1.1,2.4,3*31
$GLGSA,A,3,66,67,68,75,77,84,85,86,,,,,2.6,1.1,2.4,3*31
```

#### 8.6.2.7 Heading True (GLHDT)

```
$GLHDT,90.000,T*10
$GLHDT,90.000,T*10
$GLHDT,90.000,T*10
$GLHDT,90.000,T*10
$GLHDT,90.000,T*10
$GLHDT,90.000,T*10
```

#### 8.6.2.8 Time and date (GLZDA)

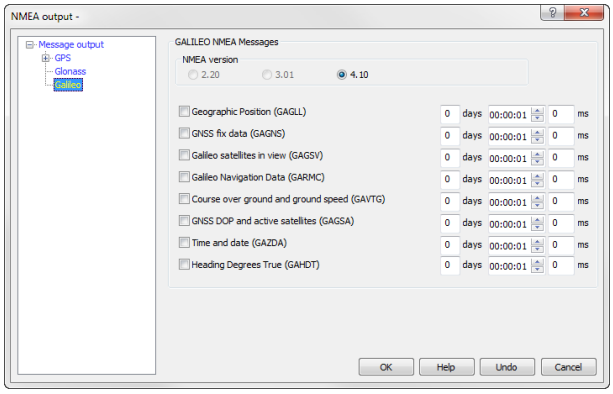
Spirent assumes a simple time zone offset of one hour per 15 degrees longitude.

```
$GLZDA,000000.00,01,01,2011,00,00*78
$GLZDA,000001.00,01,01,2011,00,00*79
$GLZDA,000002.00,01,01,2011,00,00*7A
$GLZDA,000003.00,01,01,2011,00,00*7B
$GLZDA,000004.00,01,01,2011,00,00*7C
$GLZDA,000005.00,01,01,2011,00,00*7D
```

### 8.6.3 Galileo

***Note**: To log Galileo NMEA messages in nmea.txt and provide an NMEA output file containing Galileo NMEA messages, your scenario must assign at least one antenna to the Galileo constellation.*

For Galileo satellites, SimGEN currently supports NMEA version 4.10. Use this dialog to select each message you want to output, together with the Output interval in **days** and **hh:mm:ss ms**. The default interval in each case is one second.




The following sections give examples of the Galileo NMEA message output files. In the output file, Galileo messages begin with '$GA' followed by the three-letter acronym of the message.

These Galileo example messages were recorded at the same time as the ***GPS*** (page 8-11) and ***GLONASS*** (page 8-14) messages.

#### 8.6.3.1 Geographic position (GAGLL)

```
$GAGLL,5025.50000,N,00335.75000,W,000000,A*29
$GAGLL,5025.50248,N,00335.70809,W,000001,A*22
$GAGLL,5025.51270,N,00335.66919,W,000002,A*2C
$GAGLL,5025.52993,N,00335.63693,W,000003,A*20
$GAGLL,5025.55257,N,00335.61429,W,000004,A*22
$GAGLL,5025.57851,N,00335.60339,W,000005,A*2A
```

#### 8.6.3.2 Fix data (GAGNS)

```
$GAGNS,000000,5025.50000,N,00335.75000,W,,AN,A,10,,47.98,52.02,,,V*47
$GAGNS,000001,5025.50248,N,00335.70809,W,,AN,A,10,,47.99,52.01,,,V*4E
$GAGNS,000002,5025.51270,N,00335.66919,W,,AN,A,10,,47.99,52.01,,,V*40
$GAGNS,000003,5025.52993,N,00335.63693,W,,AN,A,10,,47.99,52.01,,,V*4C
$GAGNS,000004,5025.55257,N,00335.61429,W,,AN,A,10,,47.99,52.01,,,V*4E
$GAGNS,000005,5025.57851,N,00335.60339,W,,AN,A,10,,47.99,52.01,,,V*46
```


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#### 8.6.3.3 Satellites in view (GAGSV)

```
$GAGSV,13,1,10,4,12,150,60,5,31,106,61,6,26,54,61,15,11,332,60,1*41
$GAGSV,13,1,10,4,12,150,60,5,31,106,61,6,26,54,61,15,11,332,60,1*41
$GAGSV,13,1,10,4,12,150,60,5,31,106,61,6,26,54,61,15,11,332,60,1*41
$GAGSV,13,1,10,4,12,150,60,5,31,106,61,6,26,54,61,15,11,332,60,1*41
$GAGSV,13,1,10,4,12,150,60,5,31,106,61,6,26,54,61,15,11,332,60,1*41
$GAGSV,13,1,10,4,12,150,60,5,31,106,61,6,26,54,61,15,11,332,60,1*41
```

#### 8.6.3.4 Navigation data (GARMC)

```
$GARMC,000000,A,5025.50000,N,00335.75000,W,97.191,90.000,010111,0.000,E,A,V*6C
$GARMC,000001,A,5025.50248,N,00335.70809,W,97.191,76.421,010111,0.000,E,A,V*68
$GARMC,000002,A,5025.51270,N,00335.66919,W,97.191,58.879,010111,0.000,E,A,V*6B
$GARMC,000003,A,5025.52993,N,00335.63693,W,97.191,41.337,010111,0.000,E,A,V*6E
$GARMC,000004,A,5025.55257,N,00335.61429,W,97.191,23.795,010111,0.000,E,A,V*64
$GARMC,000005,A,5025.57851,N,00335.60339,W,97.191,6.253,010111,0.000,E,A,V*54
```

#### 8.6.3.5 Course over ground and ground speed (GAVTG)

```
$GAVTG,23.795,T,23.795,M,97.191,N,179.997,K*60
$GAVTG,356.182,T,356.182,M,97.191,N,179.997,K*60
$GAVTG,356.182,T,356.182,M,97.191,N,179.997,K*60
$GAVTG,356.182,T,356.182,M,97.191,N,179.997,K*60
$GAVTG,356.182,T,356.182,M,97.191,N,179.997,K*60
$GAVTG,356.182,T,356.182,M,97.191,N,179.997,K*60
```

#### 8.6.3.6 DOP and active satellites (GAGSA)

```
$GAGSA,A,3,04,05,06,15,16,17,18,23,24,25,,,1.5,0.8,1.3,2*38
$GAGSA,A,3,04,05,06,15,16,17,18,23,24,25,,,1.5,0.8,1.3,2*38
$GAGSA,A,3,04,05,06,15,16,17,18,23,24,25,,,1.5,0.8,1.3,2*38
$GAGSA,A,3,04,05,06,15,16,17,18,23,24,25,,,1.5,0.8,1.3,2*38
$GAGSA,A,3,04,05,06,15,16,17,18,23,24,25,,,1.5,0.8,1.3,2*38
$GAGSA,A,3,04,05,06,15,16,17,18,23,24,25,,,1.5,0.8,1.3,2*38
```

#### 8.6.3.7 Time and date (GAZDA)

Spirent assumes a simple time zone offset of one hour per 15 degrees longitude.

```
$GAZDA,000000.00,01,01,2011,00,00*75
$GAZDA,000001.00,01,01,2011,00,00*74
$GAZDA,000002.00,01,01,2011,00,00*77
$GAZDA,000003.00,01,01,2011,00,00*76
$GAZDA,000004.00,01,01,2011,00,00*71
$GAZDA,000005.00,01,01,2011,00,00*70
```

#### 8.6.3.8 Heading True (GAHDT)

```
$GAHDT,23.795,T*1E
$GAHDT,356.182,T*2F
$GAHDT,356.182,T*2F
$GAHDT,356.182,T*2F
$GAHDT,356.182,T*2F
$GAHDT,356.182,T*2F
```

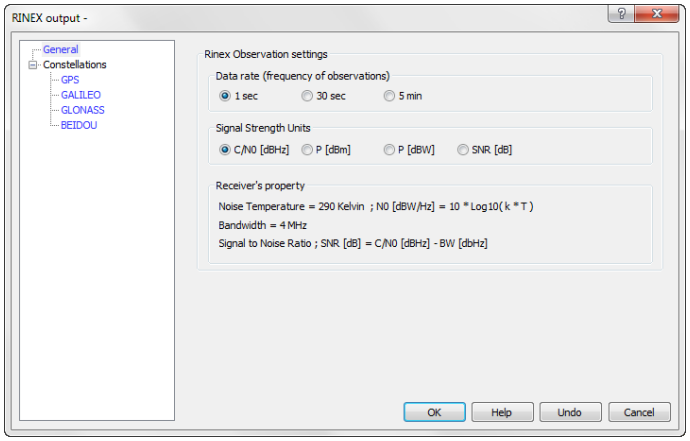

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# 8.7 RINEX output file (observation file)

To create a Rinex observation file, select **RINEX output file**, which automatically creates a RINEX observation file, **.rinex-obs*, and adds a check mark to indicate your selection.

Double-click this selection to open the **RINEX output-General** dialog.

Use the **General** dialog to set up the Observation file parameters.




| | |
|---|---|
| **Data rate (frequency of observations)** | Determines the rate at which data is written to the RINEX observation file<br>Select from:<br>**1 sec** (default)<br>**30 sec**<br>**5 min** |
| **Signal Strength Units** | Select the signal strength units you want to use, from:<br>**C/N0 (dBHz)** (default), the carrier to noise density per unit bandwidth<br>**P (dBm)**, the received RF power, in dBm<br>**P (dBW)**, the received RF power, in dBW<br>**SNR (dB)**, the signal to noise ratio in a given bandwidth, in dB |
| **Receiver's property** | Provides information Spirent uses for the above calculations, as follows:<br>Noise temperature, T, is 290 Kelvin<br>N0 (dBw/Hz) is given by $10*Log_{10}$ (k*T)<br>Receiver bandwidth is 4 MHz<br>SNR (dB) is given by C/N0 (dBHz) - BW (dBHz) |

Now, select the constellations whose parameters you want to record from:

- → ***GPS*** (page 8-19)
- → ***Galileo*** (page 8-20)
- → ***GLONASS*** (page 8-21), and / or
- → ***BeiDou*** (page 8-22)

and select the parameters you want to record in the RINEX observation file.

For all constellations, if you define code offsets to the satellite signal power using **<Constellation Editor>-Signal Control-Signal Power**, the code offsets will be present in the RINEX observation data


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### 8.7.1 GPS

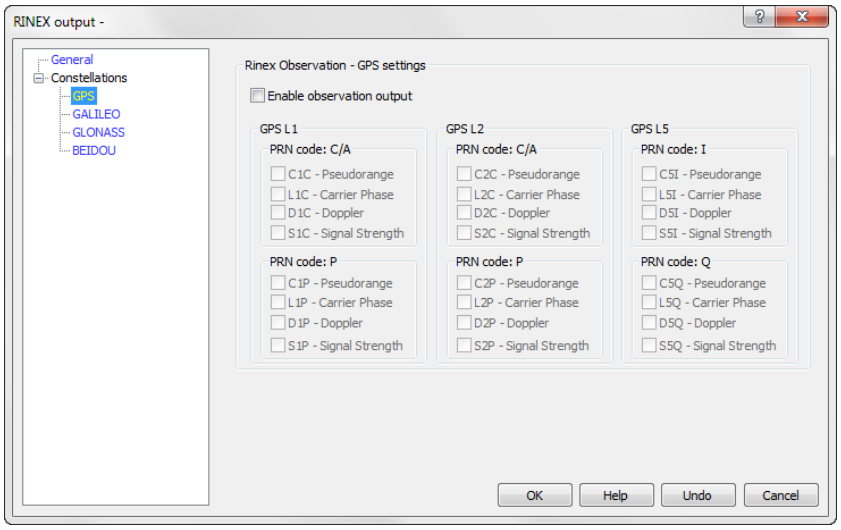
***Notes**:*

***1)** SimGEN does not let you select individual PRN channels for L5; therefore, RINEX observation data for GPS L5 will be with respect to PRN channel I*

***2)** GPS Inter-signal bias (ISC), see **GPS-**Signal Control - General (page 8-19), affects navigation data only and is not present in the RINEX observation file*

***3)** SimGEN applies GPS power combination settings, see **GPS-**Signal Control - General (page 8-19), in the signal generator firmware, these settings will be not present in the RINEX observation file*

Use this dialog to set the GPS parameters you want to record in the RINEX observation file:




| | |
|---|---|
| **Enable observation output** | Deselect (default): does not record GPS data to the RINEX observation file<br>Select: records GPS data to the RINEX observation file (enables the parameters in **GPS L1**, **GPS L2** and **GPS L5**) |
| **GPS L1**,<br>**GPS L2** and<br>**GPS L5** | Select the parameters to record to the RINEX observation file, as follows:<br>**Pseudorange**<br>for **L1** and **L2** (**PRN code C/A** and **P**), and **L5** (**PRN code: I** only)<br>**Carrier Phase**<br>for **L1** and **L2** (**PRN code C/A** and **P**), and **L5** (**PRN code: I** only)<br>**Doppler**<br>for **L1** and **L2** (**PRN code C/A** and **P**), and **L5** (**PRN code: I** only)<br>**Signal Strength** (using the units you select in the **General** dialog, see ***RINEX output file (observation file)*** (page 8-19)<br>for **L1** and **L2** (**PRN code C/A** and **P**), and **L5** (**PRN code: I** only) |


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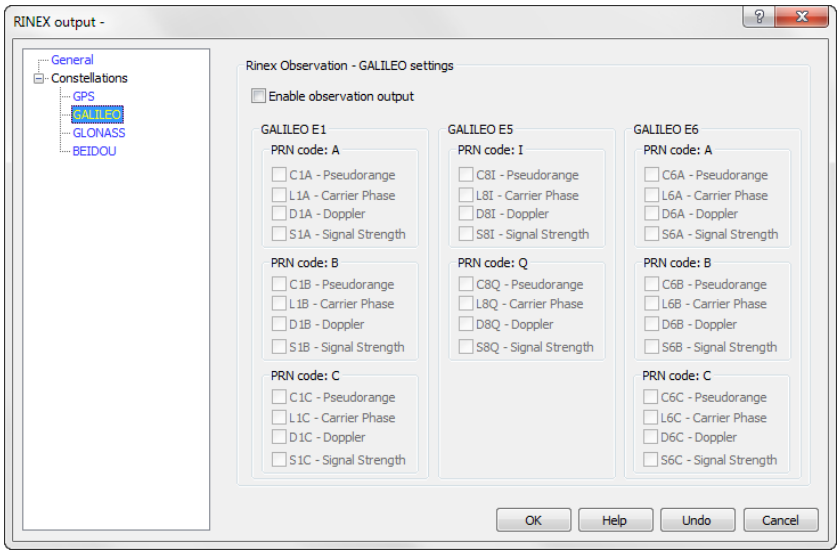
## 8.7.2 Galileo

***Notes***:

***1)*** *Applying PRN codes to Galileo channels may result in modification of the satellite RF output power. SimGEN applies these modifications in the signal generator firmware and they will not be present in the RINEX observation data*

***2)*** *SimGEN applies the post-filtering power sharing ratio (E1/E6 power sharing offset), see* ***Galileo-Signal control - Signal power*** *(page 12-21), in the signal generator firmware and it will not be present in the RINEX observation data*

Use this dialog to set the Galileo parameters you want to record in the RINEX observation file:




| | |
|---|---|
| **Enable observation output** | Deselect (default): does not record Galileo data to the RINEX observation file<br>Select: records Galileo data to the RINEX observation file (enables the parameters in **GALILEO E1**, **GALILEO E5** and **GALILEO E6**) |
| **GALILEO E1**, **GALILEO E5** and **GALILEO E6** | Select the parameters to record to the RINEX observation file, as follows:<br>**Pseudorange**<br>for **E1** and **E6** (**PRN code A**, **B** and **C**), and **E5** (**PRN code: I** and **Q**)<br>**Carrier Phase**<br>for **E1** and **E6** (**PRN code A**, **B** and **C**), and **E5** (**PRN code: I** and **Q**)<br>**Doppler**<br>for **E1** and **E6** (**PRN code A**, **B** and **C**), and **E5** (**PRN code: I** and **Q**)<br>**Signal Strength** (using the units you select in the **General** dialog, see ***RINEX output file (observation file)*** (page 8-19)<br>for **E1** and **E6** (**PRN code A**, **B** and **C**), and **E5** (**PRN code: I** and **Q**) |


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### 8.7.3 GLONASS

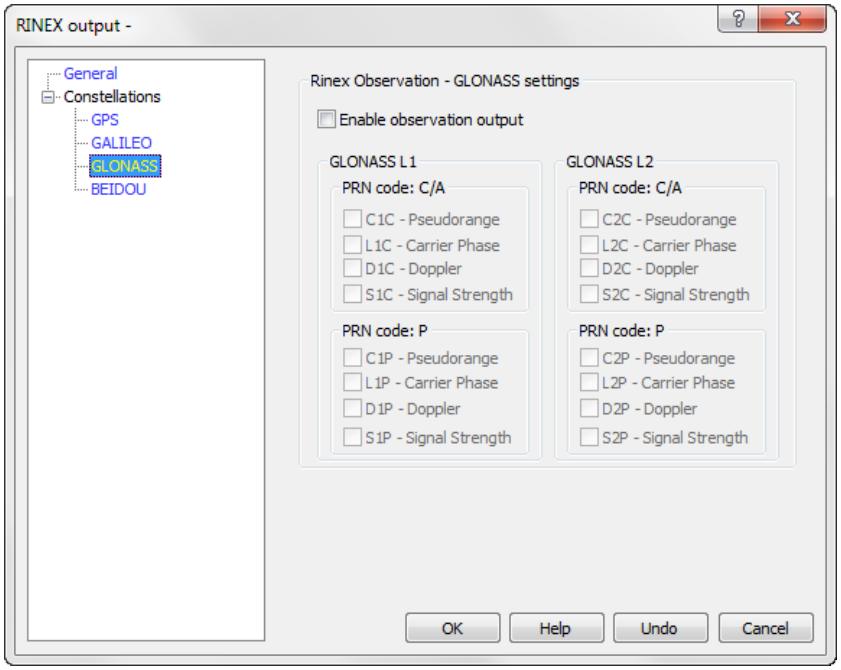
***Notes:***

***1)*** *Applying PRN codes to GLONASS channels may result in modification of the satellite RF output power. SimGEN applies these modifications in the signal generator firmware and they will not be present in the RINEX observation data*

***2)*** *According to version 3.03 of the RINEX specification document, the GLONASS Code Phase Bias Correction Record is "…used to align code and phase observations.." and has been implemented since "…some GNSS receivers produce biased GLONASS observations[…]the code-phase bias results in the code and phase observations not being measured at the same time…".*
*Spirent assumes the GLONASS code-phase alignment is unknown.*

***3)*** *Currently, SimGEN does not support GLONASS L3*

Use this dialog to set the GLONASS parameters you want to record in the RINEX observation file:

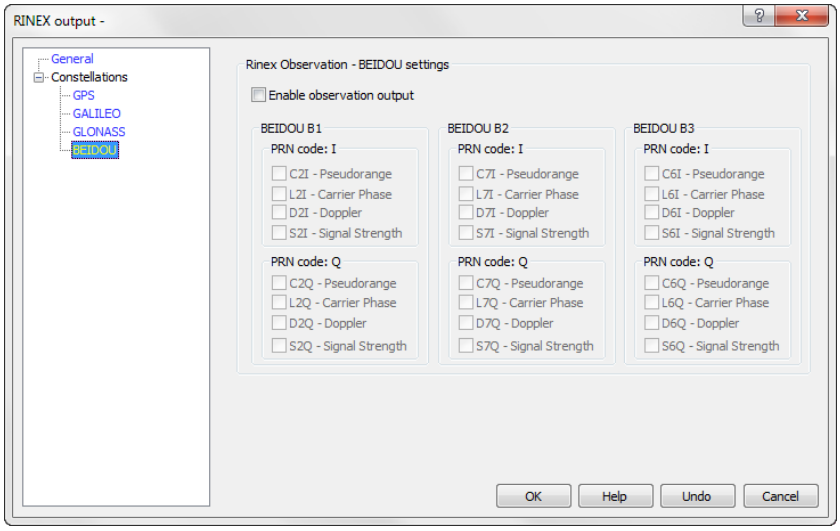



| | |
|---|---|
| **Enable observation output** | Deselect (default): does not record GLONASS data to the RINEX observation file<br>Select: records GLONASS data to the RINEX observation file (enables the parameters in **GLONASS L1** and **GLONASS L2**) |
| **GLONASS L1** and **GLONASS L2** | Select the parameters to record to the RINEX observation file, as follows:<br>**Pseudorange**<br>for **L1** and **L2** (**PRN code C/A** and **P**)<br>**Carrier Phase**<br>for **L1** and **L2** (**PRN code C/A** and **P**)<br>**Doppler**<br>for **L1** and **L2** (**PRN code C/A** and **P**)<br>**Signal Strength** (using the units you select in the **General** dialog, see ***RINEX output file (observation file)*** (page 8-19)<br>for **L1** and **L2** (**PRN code C/A** and **P**) |

### 8.7.4 BeiDou

***Note***: *SimGEN does not provide the option to select individual PRN channels for BeiDou B1, B2 or B3; therefore, RINEX observation data for these carrier frequencies will be with respect to PRN channel I*

Use this dialog to set the BeiDou parameters you want to record in the RINEX observation file:




| | |
|---|---|
| **Enable observation output** | Deselect (default): does not record BeiDou data to the RINEX observation file<br>Select: records BeiDou data to the RINEX observation file (enables only the **I** parameters in **BeiDou B1**, **BeiDou B2** and **BeiDou B3**) |
| **BeiDou B1**, **BeiDou B2** and **BeiDou B3** | Select the parameters to record to the RINEX observation file, as follows:<br>**Pseudorange**<br>for **B1**, **B2** and **B3** (**PRN code I** only)<br>**Carrier Phase**<br>for **B1**, **B2** and **B3** (**PRN code I** only)<br>**Doppler**<br>for **B1**, **B2** and **B3** (**PRN code I** only)<br>**Signal Strength** (using the units you select in the **General** dialog, see ***RINEX output file (observation file)*** (page 8-19)<br>for **B1**, **B2** and **B3** (**PRN code I** only) |

## 8.8 RTCM definition file

***Notes***:

***1)*** *SimGEN can only open COM ports up to and including COM9*

***2)*** *Reference k) gives details on the timing reference of RTCM corrections*

***3)*** *The licenced constellations you enable in the* ***Scenario Contents*** *window enable the relevant satellites in the* ***RTCM definition file*** *dialogs*

RTCM corrections are available from the C50r SimGEN Host (or SimGEN Controller) serial port you allocate to the RTCM output.

First, you must allocate the RS-232 port to RTCM corrections. See **SimGEN options-*RS-232 port settings*** (page 5-28) and select **Used by: RTCM output** for the RS-232 port (**COM 1** or **COM 2**) you want to use.

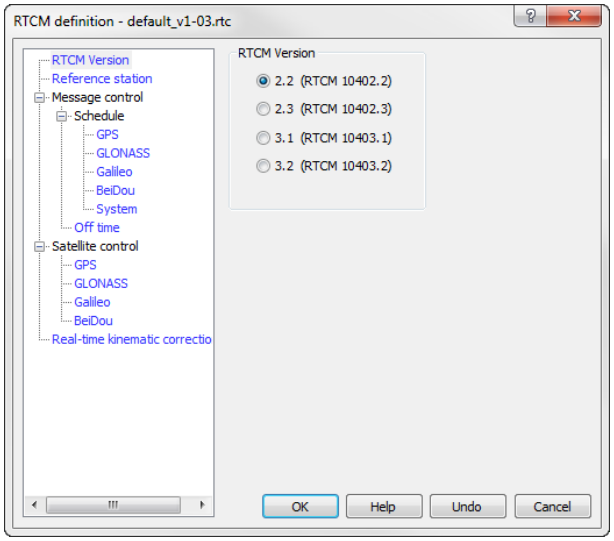
Now, for the RS232 port you assign to the RTCM output, click **Settings…** and ensure the RS-232 Port Settings (Bits per second, Data bits, Parity, Stop bits and Flow control) of your SimGEN Controller match the RTCM correction input port of your receiver.

Click **OK**.


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### 8.8.1 RTCM version

In the **Scenario contents** window, select **Scenario-Options-RTCM definition file** to open the **RTCM definition** dialog, where you first select the RTCM version you want to use. Dialogs that are version dependant display your selection of RTCM version number in the upper-right corner:



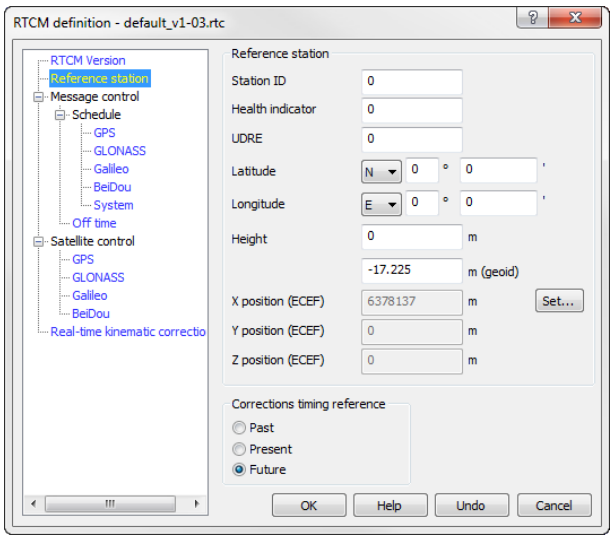

The **RTCM definition** dialog sets up RTCM differential corrections for the scenario. This table details the sections relating to each version of RTCM that SimGEN supports.

| RTCM version | Description | See |
|---|---|---|
| 2.2 | GPS and GLONASS satellites messages -see reference j) | ***RTCM version 2.2 and 2.3*** (page 8-25) |
| 2.3 | GPS and GLONASS satellite messages - see reference k) | ***RTCM version 2.2 and 2.3*** |
| 3.1 | GPS, GLONASS and Galileo satellite messages, and System messages - see reference s) | ***RTCM version 3.1*** (page 8-30) |
| 3.2 | GPS, GLONASS, Galileo and BeiDou satellite messages - see reference t) | ***RTCM version 3.2*** (page 8-36) |

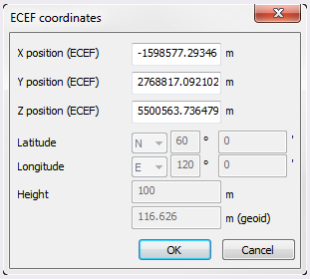
### 8.8.2 Reference station

***Note**: **Reference station** parameters are independent of RTCM version*

Use this dialog to set the **Reference station** to approximately the same location as the vehicle(s) receiving the corrections. You can use **Latitude**, **Longitude** and **Height**, or ECEF coordinates.




Enter the **Reference station** position as **Latitude**, **Longitude** and **Height** or **X**, **Y**, **Z** in ECEF co-ordinates. Click **Set** to display the alternative position co-ordinates.

| | | | |
|---|---|---|---|
| **Station ID** | Units: none | Range: 0 to 1023 | Default: 0 |
| **Health indicator** | The health of the reference station | Range: 0 to 7<br>Where:<br>7 - not working properly<br>6 - not monitored<br><br>0 to 6 are specified by the individual service provider and do not have a fixed meaning | Default: 0 |
| **UDRE** | Units: none | Range: 0 to 3 | Default: 0 |
| **Latitude** | Units: degrees, minutes | Range: N 90° 0’ to S 90° 0´ | |
| **Longitude** | Units: degrees, minutes | Range: E 180° 0.0´ to W 180° 0.0´ | |
| **Height** | Units: metres | Range: -9 999 to 30 000 m | Default: 0<br>(-18 for geoid) |
| Clicking **Set…** opens this dialog in which you can enter the reference location in **ECEF coordinates**:<br>  <br>Notice **Latitude**, **Longitude** and **Height** update automatically as you move between the X, Y and Z positions. | | | |
| **X position (ECEF)**<br>**Y position (ECEF)**<br>**Z position (ECEF)** | Units: metres | Range: -1E10 to 1E10 m | |
| **Corrections timing reference** | Choose from:<br>**Past** (delays timing by two seconds)<br>**Present** (delays timing by one second)<br>**Future** (uses the current timing) | | |




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## 8.8.3 RTCM version 2.2 and 2.3

These versions support messages for GPS and GLONASS satellites.

### 8.8.3.1 Message control - Schedule

***Note**:*

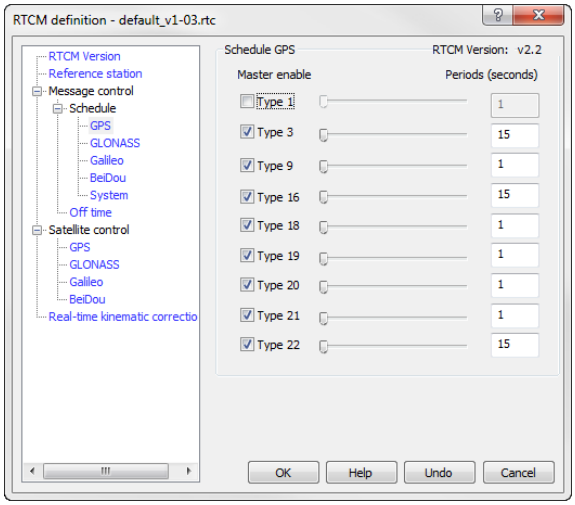
***1)** RTCM versions 2.2 and 2.3 do not support Galileo or BeiDou constellations.*

***2)** SimGEN enables all **Message schedules** by default, with each slider fully to the left-hand side.*

***3)** The screenshots in this section refer to version 2.2, version 2.3 is identical.*

Use this dialog to enable or disable the Schedule for GPS and GLONASS Message types.
Use the slider to set the period between transmissions of each message type.

This figure shows **GPS-Master enable-Type 1** deselected, with all other **Types** selected, for RTCM version 2.2:

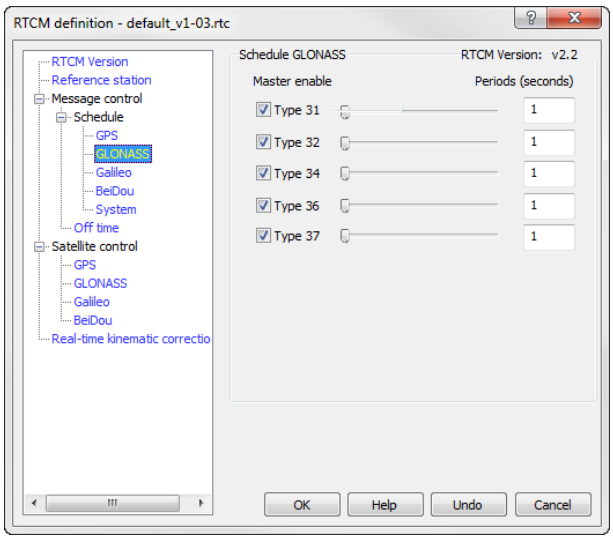



The **Satellite control** dialog in this figure (page 8-28) reflect the settings in the above figure.

The following table details the **Message types** and their transmission intervals.

| Message type | Transmission interval, s | Description - see reference k) |
|---|---|---|
| **1** | 1 to 120 | Differential GPS Corrections |
| **3** | 15 to 300 | GPS Reference Station Parameters |
| **9** | 1 to 120 | GPS Partial Correction Set |
| **16** | 15 to 300 | GPS Special Message |
| **18** | 1 to 120 | RTK Uncorrected Carrier Phases |
| **19** | 1 to 120 | RTK Uncorrected Pseudoranges |
| **20** | 1 to 120 | RTK Carrier Phase Corrections |
| **21** | 1 to 120 | RTK/Hi-Accuracy Pseudorange Corrections |
| **22** | 15 to 300 | Extended Reference Station Parameters |

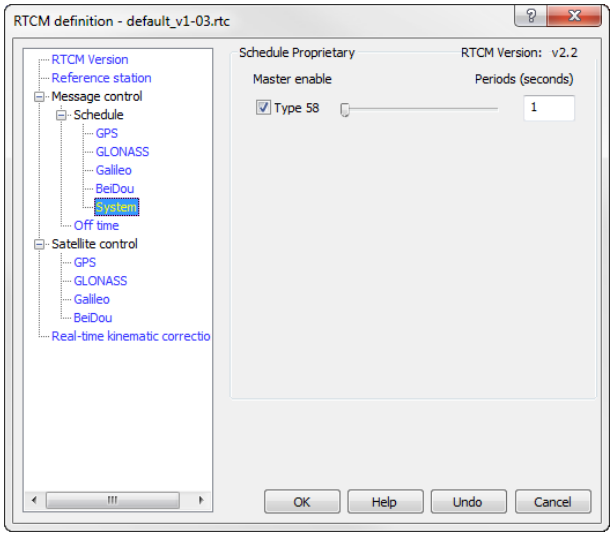
**GLONASS** dialog:




The following table details the **Message types** and their transmission intervals.

| Message type | Transmission interval, s | Description - see reference k) |
|---|---|---|
| **31** | 1 to 120 | Differential GLONASS Corrections |
| **32** | 1 to 120 | GLONASS Reference Station Parameters |
| **34** | 1 to 120 | GLONASS Partial Correction Set |
| **36** | 1 to 120 | GLONASS Special Message |
| **37** | 1 to 120 | GNSS System Time Offset |

**System** dialog:




The following table details the **Message type** and transmission interval.

| Message type | Transmission interval, s | Description - see reference k) |
|---|---|---|
| **58** | 1 to 120 | A Spirent-defined format you can select in **Message Control-Schedule-System** |

### 8.8.3.2 Message control - Off time

***Notes***:

***1)*** *RTCM versions 2.2 and 2.3 do not support Galileo or BeiDou constellations.*

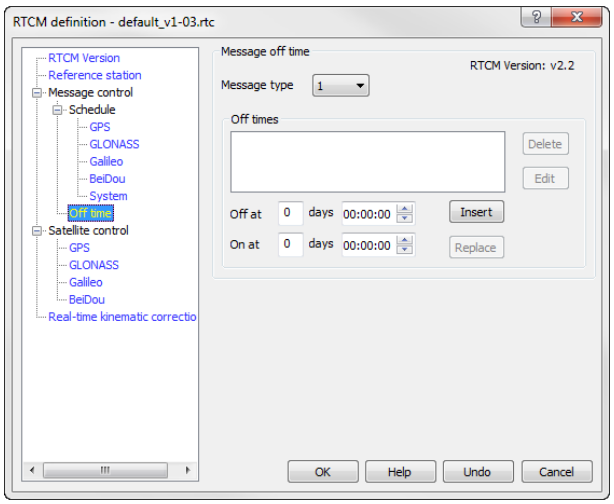

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***2)*** *An error message will display if you attempt to turn* ***On*** *a Message type before you turn it* ***Off****.*

***3)*** *All constellations use this dialog, the* ***Message type*** *depends on the constellation and RTCM version:*
*RTCM version 2.2 and 2.3, see this section*
*RTCM version 3.1, see* ***Message control - Off time*** *page 8-32*
*RTCM version 3.2, see* ***Message control - Off time*** *page 8-37*

***4)*** *The screenshots in this section refer to version 2.2, version 2.3 is identical.*

Set the Message off and on times of each **Message type** using the **Message control** dialog:




| | | | |
|---|---|---|---|
| **Message type** | Select the **Message type** you want to set. | | |
| **Off at**<br>**On at** | Units:<br>days hh:mm:ss | Range: 0 00:00:00<br>to 23 23:59:59 | Default:<br>0 days 00:00:00 |

Type the **On** time and **Off** time click **Insert**. The times appear in the **Off times** area. There is no limit to the number of **On** and **Off** times.

Select a time in the **Off times** area and click **Edit** to edit the **On** / **Off** times.

Select a time in the **Off times** area and click **Replace** to replace these times with the times currently in the **Off at** and **On at** text boxes.

Select a time in the **Off times** area and click **Delete** to delete these **On** / **Off** times.

Click **All** to apply the times in the **Off times** area to all **Satellites**. A tick next to the **All** button confirms this action.

To edit an entry, select the line containing the entry and click **Edit**. Edit the times in the **Off times** and **On times** text boxes. Click **Insert** to insert the new data or click **Replace** to replace the data you selected with the new entries.

SimGEN arranges the entries in time-order.

### 8.8.3.3 Satellite Control

***Notes****:*

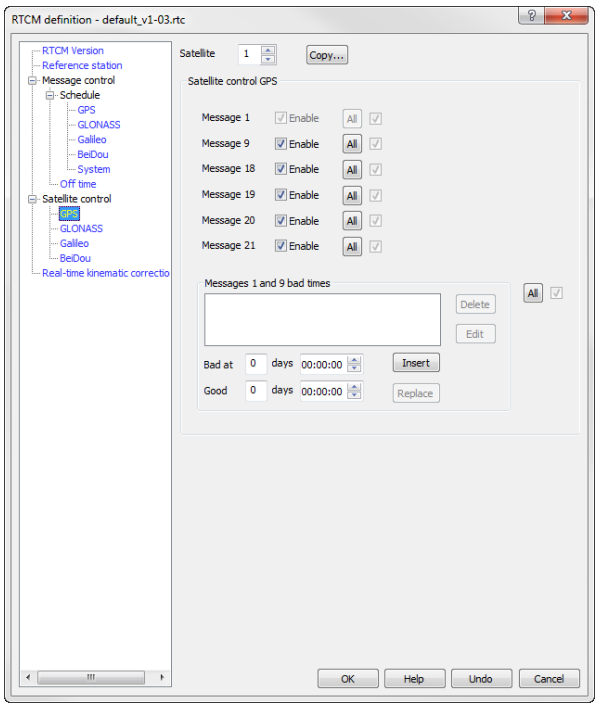
***1)*** *RTCM versions 2.2 and 2.3 do not support Galileo or BeiDou constellations.*

***2)*** *To ensure a specific* ***Message type*** *is available in the* ***Satellite control*** *area, you must enable that* ***Message type*** *in* ***Message control-Schedule****.*

***3)*** *An error message will display if you attempt to turn* ***On*** *a Message type before you turn it* ***Off****.*

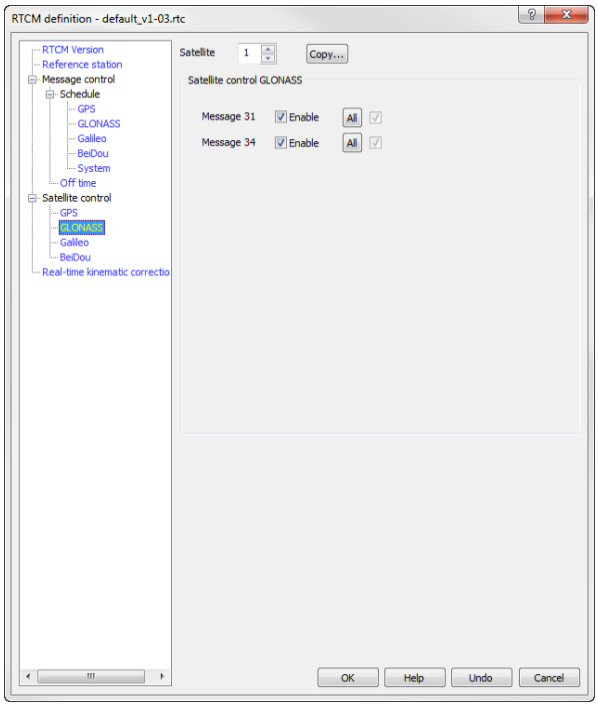
***4)*** *The screenshots in this section refer to version 2.2, version 2.3 is identical.*

**GPS** dialog:




The **Message control-Schedule** dialog in this figure (page 8-25) determines the settings in the above figure.

**GLONASS** dialog:



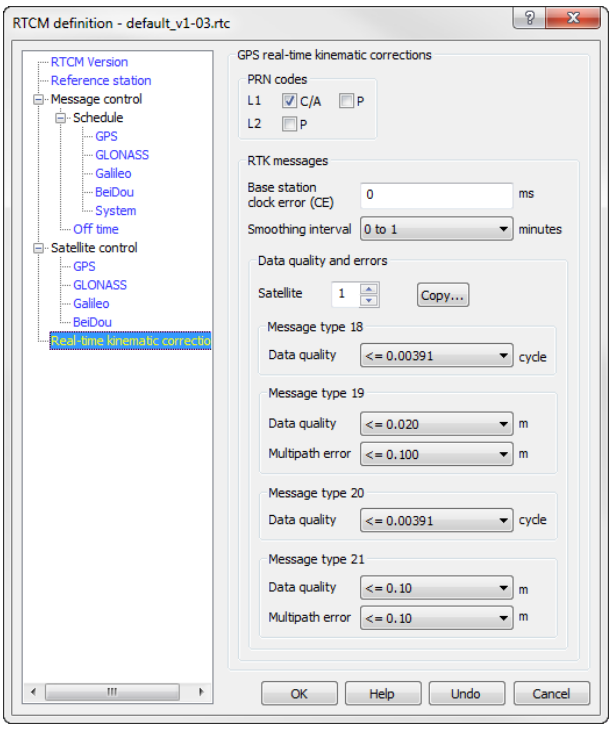

### 8.8.3.4 Real-time kinematic corrections

***Note**: RTCM versions 2.2 and 2.3 only support **Real-time kinematic corrections** for GPS satellites*

Although SimGEN calculates actual measurements, you can use the **Real-time kinematic corrections** dialog, see below, to set the data quality and errors in the messages SimGEN generates for GPS satellites.



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| | | | |
|---|---|---|---|
| **PRN codes** | Choose the PRN code from **L1-C/A**, **L1-P** and/or **L2-P** | | |
| **RTK messages** | Specify base station errors | | |
| **Base station clock error (CE)** | Units: milliseconds | Range: -1.1 to 1.1 ms | Default: 0 |
| **Smoothing interval** | Choose the interval (in minutes) from:<br>**0 to 1** (default)<br>**1 to 5**<br>**5 to 15**<br>**Undefined** | | |
| ***Note**: In a signal from a real satellite, there will be noise on the pseudo-range corrections; in the real-world, you can smooth the signal over the above intervals. SimGEN does not add noise to the signal produced by the signal generator, the signal from the signal generator is always "correct". However, SimGEN lets you set the smoothing interval in the real time kinematic correction message SimGEN will generate, but the correction data itself remains unchanged.* | | | |
| **Data quality and errors** | For each **Satellite**, specify the **Data quality** and **Multipath errors** of each **Message type**. The table below details each **Message type**. | | |
| **Satellite** | Select the **Satellite** whose settings you want to change.<br>Click **Copy** to copy these parameters to the Satellites you select in the dialog. | | |
| **Message type 18**<br>**Message type 20** | Choose **Data quality** from the values in the list.<br>Default: <=0.00391 cycles | | |
| **Message type 19**<br>**Message type 21** | Choose **Data quality** from the values in the list.<br>Default: <=0.020 m (**Message type 19**)<br>Default: <= 0.10 m (**Message type 21**)<br><br>Choose **Multipath error** from the values in the list.<br>Default: <=0.10 m (**Message type 19** and **Message type 21**) | | |

***Note**: Message types 18 and 19, 20 and 21 are not corrected by the ephemerides contained in the satellite message*

| Message type | Description |
|---|---|

| Message type | Description |
|---|---|
| **18** | Provides uncorrected carrier phase measurements |
| **19** | Provides uncorrected pseudorange measurements |
| **20** | Provides carrier phase data corrections |
| **21** | Provides pseudorange data corrections |

## 8.8.4 RTCM version 3.1

Version 3.1 supports messages for GPS, GLONASS and Galileo satellites.

### 8.8.4.1 Message control - Schedule

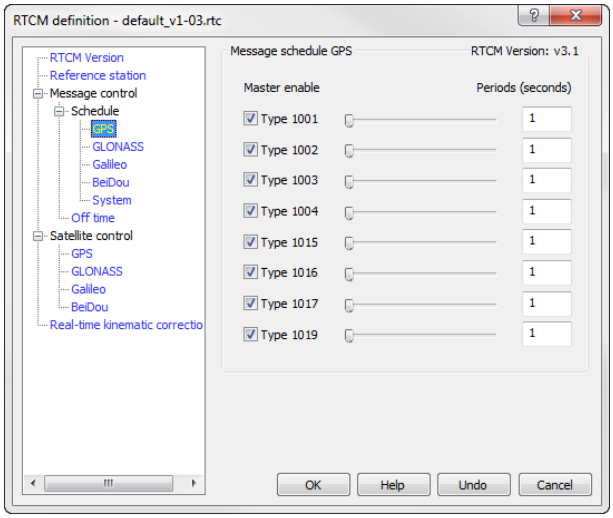
***Notes**:*

***1)** SimGEN enables all **Message schedules** by default, with each slider fully to the left-hand side.*

***2)** RTCM version 3.1 and version 3.2 use this dialog. RTCM version 3.2 also supports BeiDou satellites.* ***Message control - Schedule** (page 8-36) shows the dialog for BeiDou satellites.*

Use this dialog to enable or disable the **Schedule** for GPS, GLONASS and Galileo Message types.
Use the slider to set the period between transmissions of each message type.

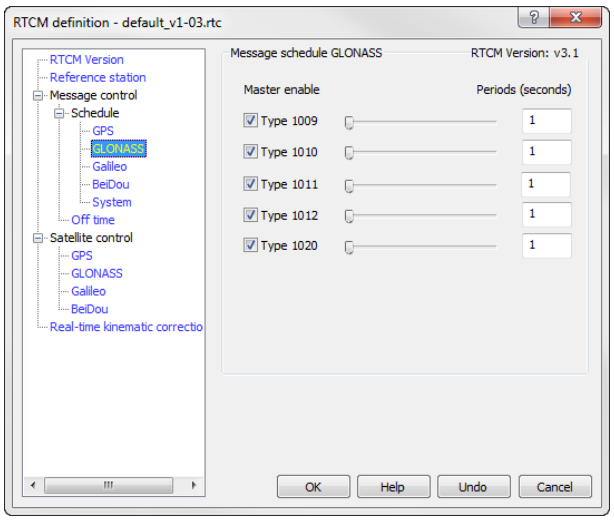
**GPS** dialog:




| Message type | Transmission interval, s | Description - see reference s) |
|---|---|---|
| **1001** | 1 to 120 | L1-only GPS RTK observables |
| **1002** | 1 to 120 | Extended L1-only GPS RTK observables |
| **1003** | 1 to 120 | L1 and L2 GPS RTK observables |
| **1004** | 1 to 120 | Extended L1 and L2 GPS RTK observables |
| **1015** | 1 to 120 | GPS Ionospheric correction differences |
| **1016** | 1 to 120 | GPS Geometric correction differences |
| **1017** | 1 to 120 | GPS combined Geometric and Ionospheric correction differences |
| **1019** | 1 to 120 | GPS Ephemerides |

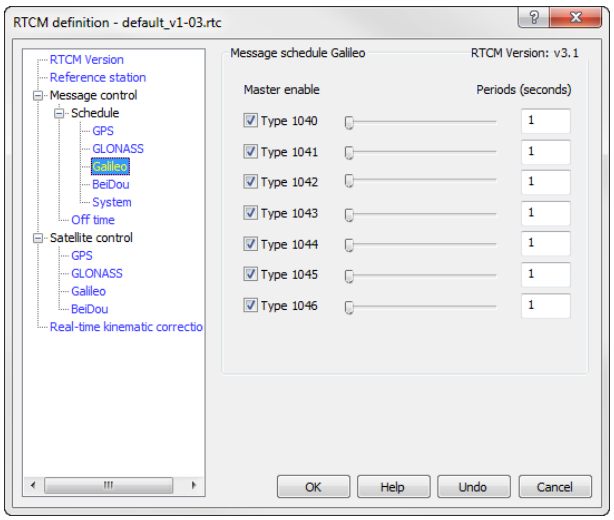
**GLONASS** dialog:


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| Message type | Transmission interval, s | Description - see reference s) |
|---|---|---|
| **1009** | 1 to 120 | L1-only GLONASS RTK Observables |
| **1010** | 1 to 120 | Extended L1-only GLONASS RTK Observables |
| **1011** | 1 to 120 | L1 and L2 GLONASS RTK Observables |
| **1012** | 1 to 120 | Extended L1 and L2 GLONASS RTK Observables |
| **1020** | 1 to 120 | GLONASS Ephemerides |

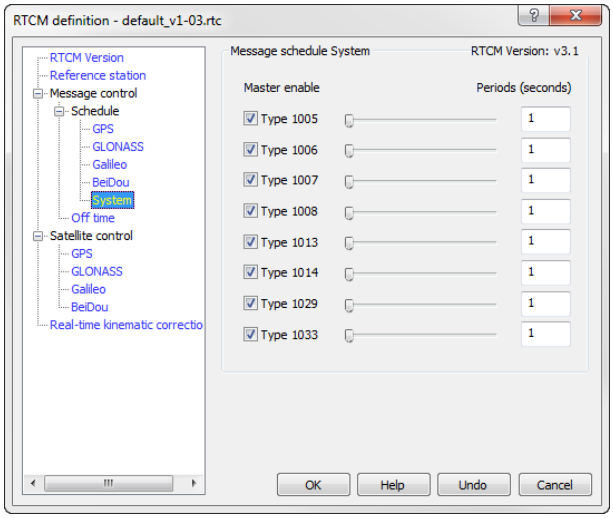
**Galileo** dialog:




| Message type | Transmission interval, s | Description - see reference t) |
|---|---|---|
| **1045** | 1 to 120 | F/NAV Satellite Ephemeris Data (added in RTCM version 3.2) |

Currently, Spirent are unable to provide further details on Galileo Message types and their transmission intervals.

**System** dialog:



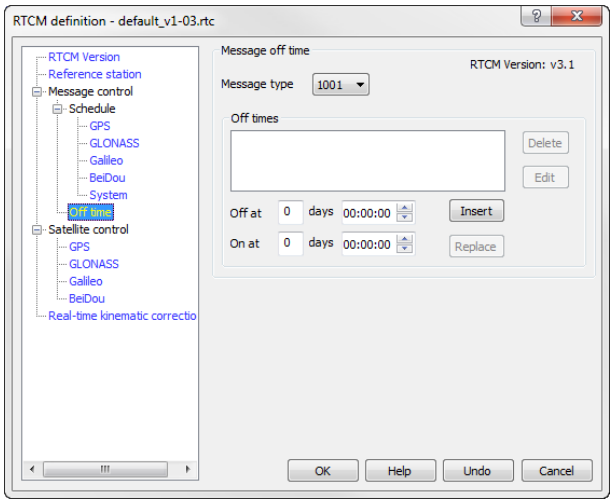

The following table details the Message types and their transmission intervals.

| Message type | Transmission interval, s | Description - see reference s) |
|---|---|---|
| **1005** | 1 to 120 | Station coordinates |
| **1006** | 1 to 120 | Station coordinates |
| **1007** | 1 to 120 | Antenna description |
| **1008** | 1 to 120 | Antenna description |
| **1013** | 1 to 120 | System parameters |
| **1014** | 1 to 120 | Network RTK correction |
| **1029** | 1 to 120 | Test string |
| **1033** | 1 to 120 | Antenna and receiver description |

### 8.8.4.2 Message control - Off time

***Note**: An error message will display if you attempt to turn **On** a Message type before you turn it **Off**.*

This dialog is the same as ***Message control - Off time*** (page 8-26) for RTCM version 2.2, except for the available **Message types**:





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### 8.8.4.3 Satellite Control

***Notes**:*

***1)** To ensure a specific **Message type** is available in the **Satellite control** area, you must enable that **Message type** in **Message control-Schedule**.*

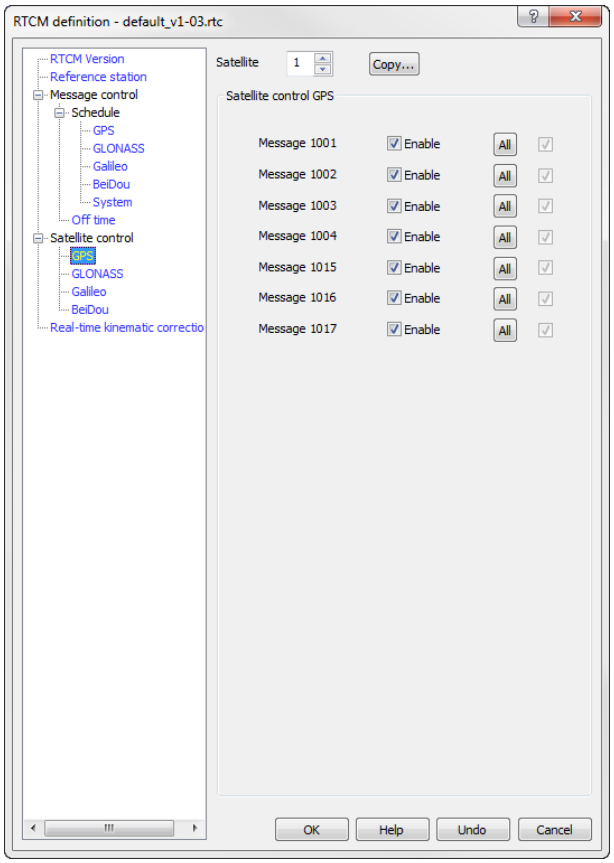
***2)** RTCM version 3.1 and version 3.2 use this dialog. RTCM version 3.2 also supports BeiDou satellites. **Satellite Control** (page 8-37) shows the dialog for BeiDou satellites.*

In this dialog, for each **Master enable** you previously deselected in ***Message control - Schedule*** (page 8-30), that Message number is shown as unavailable. Click **Copy** to copy the settings you make for this satellite to the satellites you select in the **Copy** dialog.

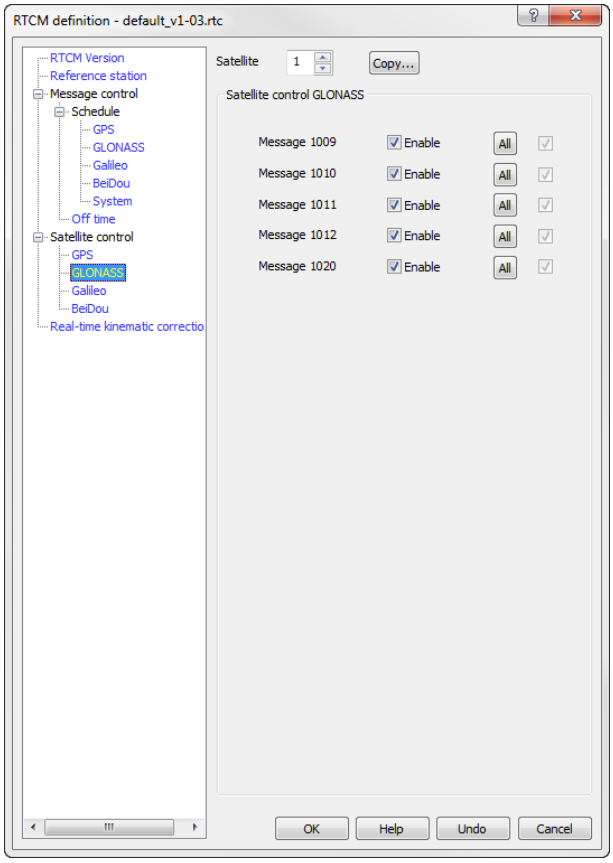
Deselect / select **Enable** to disable / enable the message types for that satellite.

Click **All** to enable or disable the Message type for all satellites.

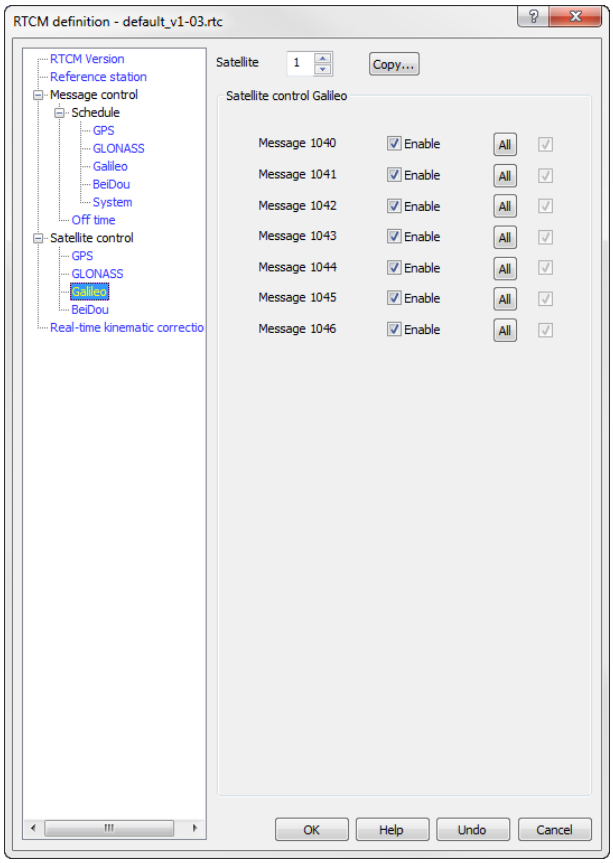
**GPS** dialog:



**GLONASS** dialog:




**Galileo** dialog:



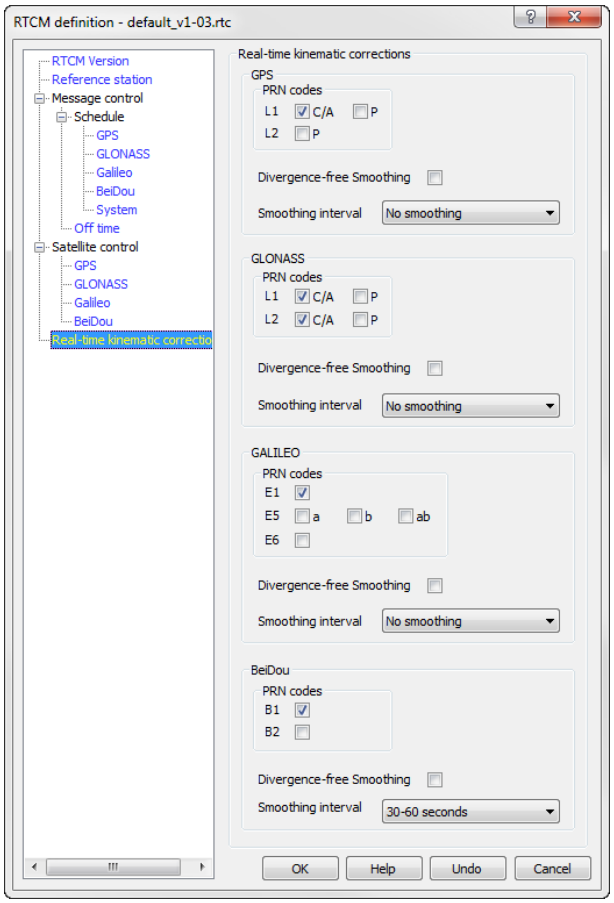


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### 8.8.4.4 Real-time kinematic corrections

***Note**: RTCM versions 3.1 and 3.2 use this dialog*

Although SimGEN calculates actual measurements, you can use the **Real-time kinematic corrections** dialog, see below, to set the data quality and errors in the messages SimGEN generates:




| | |
|---|---|
| **GPS**, **GLONASS**, **Galileo** and **BeiDou** | Set the corrections for each constellation |
| **PRN codes** | Choose the PRN code(s) from:<br>**GPS**: **L1-C/A**, **L1-P** and/or **L2-P**<br>**GLONASS**: **L1-C/A**, **L1-P, L2-C/A** and/or **L2-P**<br>**Galileo**: **E1, E5** (**a**, **b** and/or **ab**) and/or **E6**<br>**BeiDou: B1** and/or **B2** |
| **Divergence-free Smoothing** | Deselected: (default) Do not use divergence free smoothing<br>Selected: Use divergence-free smoothing, which may be continuous over the entire period the satellite is visible |
| **Smoothing interval** | The integration period over which the reference station pseudorange code phase measurements are averaged using carrier phase information.<br>Choose the interval from:<br>**No smoothing** (default for **GPS**, **GLONASS** and **Galileo**)<br>**<30 seconds**<br>**30 - 60 seconds** (default for **BeiDou**)<br>**1-2 minutes**<br>**2-4 minutes**<br>**4-8 minutes**<br>**>8 minutes**<br>**Unlimited smoothing interval** |

***Note**: In a signal received from a real satellite, there will be noise on the pseudo-range corrections; in the real-world, you can smooth the signal over the above intervals.*
*SimGEN does not add noise to the signal the signal generator produces, the signal from the signal generator is always "correct".*
*SimGEN lets you set the **Smoothing interval** (and whether **Divergence-free smoothing** is in use) in the real time kinematic correction message that SimGEN generates. However, the correction data itself remains unchanged.*

## 8.8.5 RTCM version 3.2

This version supports messages for GPS, GLONASS, Galileo and BeiDou satellites.

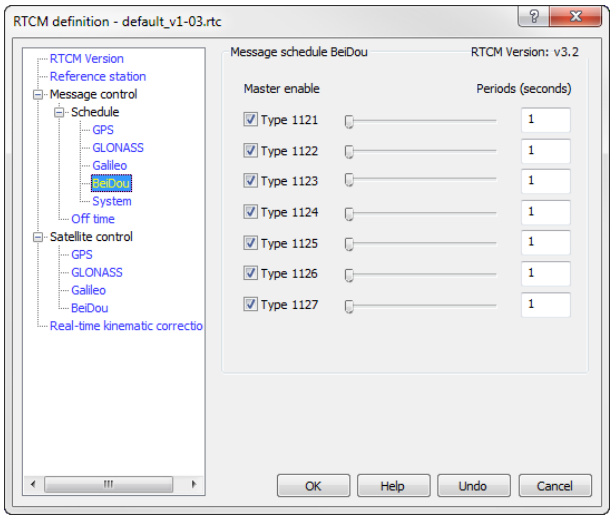
### 8.8.5.1 Message control - Schedule

***Notes**:*

***1)** SimGEN enables all **Message schedules** by default, with each slider fully to the left-hand side.*

***2)** RTCM version 3.1 and version 3.2 use this dialog. RTCM version 3.2 also supports BeiDou satellite. **Message control - Schedule** (page 8-30) shows the dialog for RTCM version 3.1.*

**BeiDou** dialog:




The following table details the Message types and their transmission intervals.

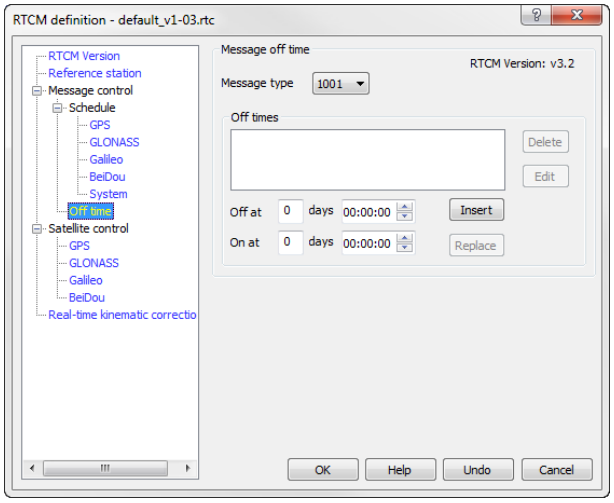
| Message type | Transmission interval, s | Description (see reference t) |
|---|---|---|
| **1121** | 1 to 120 | Compact BeiDou Pseudoranges (MSM1) |
| **1122** | 1 to 120 | Compact BeiDou Phase Ranges (MSM2) |
| **1123** | 1 to 120 | Compact BeiDou Pseudoranges and Phase Ranges (MSM3) |
| **1124** | 1 to 120 | Full BeiDou Pseudoranges and Phase Ranges plus CNR (MSM4) |
| **1125** | 1 to 120 | Full BeiDou Pseudoranges, Phase Ranges, Phase Range Rate and CNR (MSM5) |
| **1126** | 1 to 120 | Full BeiDou Pseudoranges and Phase Ranges plus CNR (high resolution) (MSM6) |
| **1127** | 1 to 120 | Full BeiDou Pseudoranges, Phase Ranges, Phase Range Rate and CNR (high resolution) (MSM7) |


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### 8.8.5.2 Message control - Off time

***Note**: An error message will display if you attempt to turn **On** a Message type before you turn it **Off**.*

This dialog is the same as ***Message control - Off time*** (page 8-26) for RTCM version 2.2, except for the available **Message types**:



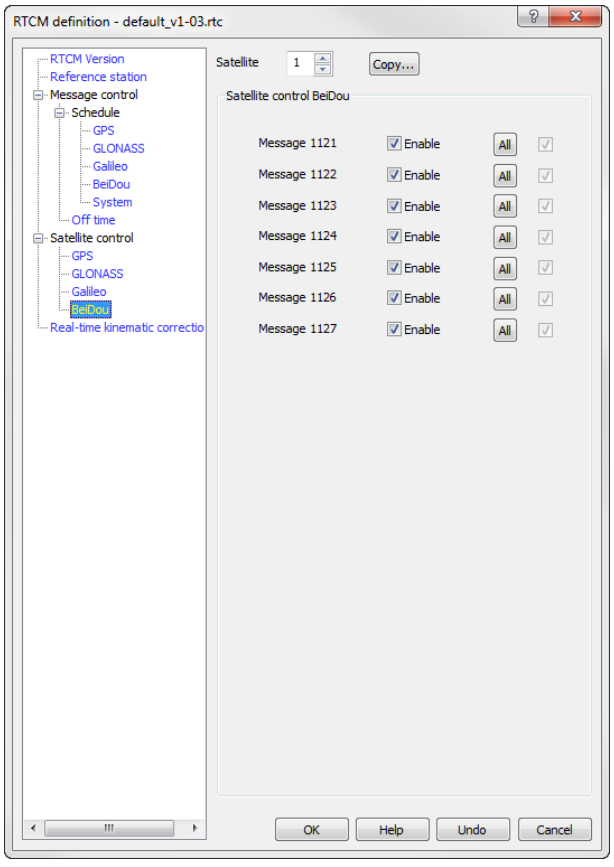

### 8.8.5.3 Satellite Control

***Notes**:*

***1)** To ensure a specific **Message type** is available in the **Satellite control** area, you must enable that **Message type** in the relevant **Message control-Schedule** dialog*

***2)** RTCM version 3.1 and version 3.2 use this dialog. RTCM version 3.2 also supports BeiDou satellite. **Satellite Control** (page 8-33) shows the dialog for RTCM version 3.1.*

**BeiDou** dialog:



In this dialog, for each **Master enable** you previously deselected in ***Message control - Schedule*** (page 8-36), that Message number is shown as unavailable. Click **Copy** to copy the settings you make for this satellite to the satellites you select in the **Copy** dialog.

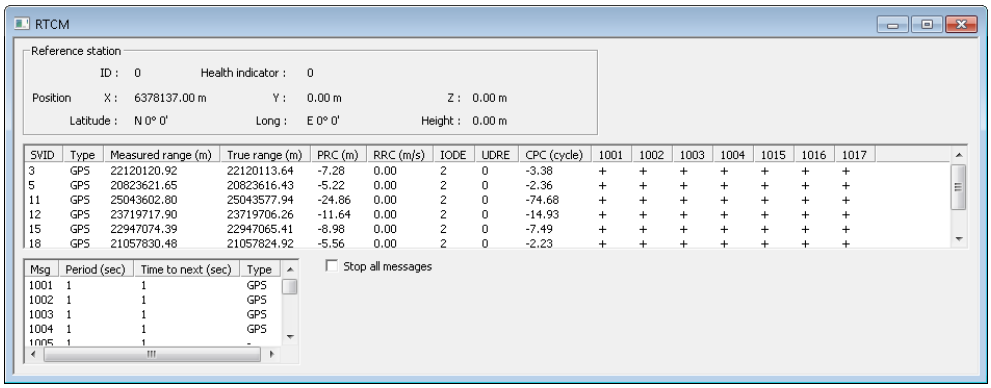
Deselect / select **Enable** to disable / enable the message types for that satellite.

Click **All** to enable or disable the Message type for all satellites.

### 8.8.6 RTCM run-time data display

***Note**: RTCM messages are binary data and include a checksum. You can decode the RTCM binary file using the **RTCM Decoder** (page 26-51).*

You can display RTCM run-time data by clicking the RTCM toolbar button. This figure shows a typical **RTCM run-time data display** window:




This figure above reflects the settings in the RTCM Version 3.1 ***Message control - Schedule*** (page 8-30) dialog, so that:

- → The upper data area shows **Satellites enabled** in ***Satellite Control*** (page 8-33)
- → The lower data area shows **Messages enabled** in ***Message control - Schedule*** (page 8-30) Notice ***Message control - Schedule*** disables **Message 1**, so this message does not appear under the **Msg** header in the lower data area.

Select **Stop all messages** to stop transmission instantly of all messages to the receiver. This state continues until you deselect **Stop all messages**.
You can resize each area as required.

## 8.9 User Actions file, *.act

***1)** SimGEN runs the commands in the User Actions file in sequence. If SimGEN cannot complete the action at the specified time it moves to the next command, it does not complete "missed" actions some time later. For example, if your User Actions file applies a pseudorange ramp to a satellite not currently visible, SimGEN (unable to find that satellite) will skip that action and move to the next action. If the scenario continues to run and that satellite subsequently rises, SimGEN will not apply the pseudorange ramp to the newly risen satellite.*

***2)** SimGEN assigns the RF Power Level to a specific Channel, not a specific SVID (also referred to as the Tx Channel).*
*This means that if you set an SVID to a specific RF Power Level and Channel, then later in your scenario force that SVID to a new Channel, SimGEN uses the Power Level assigned to the new Channel.*
*SimGEN does not "carry over" RF Power Levels originally assigned to an SVID.*
*If you want to assign a specific RF Power Level to a specific SVID, Spirent recommends you use the constellation parameter **Signal Control-Signal Power**.*

***3)** When a satellite rises, it is always set to **RF On**.*
*This means that if you set an SVID to **RF Off** and the satellite orbit takes that SVID out of view of your vehicle, when the satellite re-appears SimGEN sets that SVID to **RF On**.*
*If you want to permanently set the **RF Power Level** of a specific SVID to **Off**, Spirent recommend you deselect **Motion-orbits-present** (for example, see **GPS-Motion - Orbits** page10-21) which will remove that SVID from the constellation.*

Use the SimGEN List Editor to create a user actions file (**.act*, with a default location of the current scenario folder) containing a time-ordered list of User Actions without running a scenario. **Menus-*List Editor*** (page 5-33) describes using the List Editor.



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Select **<scenario name>-Options-User actions file:** and then double-click the selection to open the List Editor. This table details the available **Command types**:

| Command type | Comment |
|---|---|
| **Power Level** | Set a power level at a specified time to a specific vehicle and antenna, using the SVID or channel, with relative or absolute mode. You can individually set a channel, or set all channels. If your scenario uses more than one constellation type, you can apply the command to all satellites.<br>See **Main display window-*Power Adjustment*** (page 3-11) |
| **Power Mode** | Set the power mode at a specified time to a specific vehicle and antenna, using the SVID or channel. You can individually set a channel, or set all channels. If your scenario uses more than one constellation type, you can apply the command to all satellites.<br>See **Main display window-*Power Adjustment*** |
| **Power On/Off** | Set the power on or off at a specified time to a specific vehicle and antenna, using the SVID or channel. You can individually set a channel, or set all channels. If your scenario uses more than one constellation type, you can apply the command to all satellites.<br>See **Main display window-*Power Adjustment*** |
| **PR ramps** | Set a pseudorange ramp.<br>See **Channel assignment and multipath types-*Pseudorange ramps*** (page 24-1) |
| **Switch Land Mobile Multipath** | Simulate the effect of multipath signals on static and land vehicles.<br>See **Vehicle models-*Land mobile multipath*** (page 21-58) |
| **Switch Simulated Satellite** | Force, ban, include or apply multipath to selected channels or SVIDs.<br>See ***Channel assignment and multipath types*** (page 24-1) |
| **Embedded Multipath** | Set embedded multipath signals on a channel.<br>See **Channel assignment and multipath types-*Embedded multipath*** (page 24-20) |
| **Timer card pulse** | ***Note**: **Time card pulse** is not supported with GSS9000-series and GSS7000 signal generators*<br><br>If your SimGEN Controller has a timer card installed, you can send a pulse from the timer card at an **Action time** you specify, with these limits:<br>1) Do not set **Action Time** to zero<br>2) **Action time** must correspond with the setting you use in menu item ***General Options*-Simulation Iteration Rate** (page 5-15)<br>3) SimGEN limits **Action time** resolution to 10 milliseconds<br>4) **Action time** has a timing error of up to +2, -0, milliseconds |
| **Interferer commands** | You can only use these commands with the GSS7765 or GSS4765 ISS - see reference nn). |

Before running the scenario with a user actions file, you must select the menu item **Options-User Actions Recording-Enable recording of User actions**, see ***Saving User Actions to a file*** (page 5-30), if you also want to record any action you make while the scenario is running (for example, changing satellite power level using the Power Adjustment sliders).

## 8.10 User Commands file, *.ucd

***Notes**:*

***1)** The syntax of the User Commands file is critical. Reference qq) describes the User Commands format.*

***2)** Spirent recommends you do not use a User Commands file to change parameters that affect a scenario, including running a different scenario, changing a scenario, changing a vehicle and so on.*

***3)** If you want to only change motion parameters, Spirent recommends you use a User Motion file (*.umt), see **User motion files** (page 21-38).*


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The User Commands file, which is a text file with the **.ucd* extension, is an alternative to using remote commands from file - see reference qq). A User Commands file is specific to a single scenario and is stored in that scenario's folder, whereas remote commands from file are available for all scenarios.

You can use a User Commands file to change certain scenario parameters, but Note 2) above specifies certain types of parameters you should not try to change.

Spirent does not provide an editor to create User Commands files. To understand the command and file structure, Spirent recommends you first see the menu item **Options-*User Actions Recording*** (page 5-30) and then record a User Actions (**.act*) file. The User Actions file you record will contain only one command per line with the commands listed in time ascending order. Now:

- → Save your User Actions (**.act*) file in the scenario's folder.
- → Then open this User Actions file with a text editor (such as Windows Notepad).
- → Make the changes / additions you need.
- → Save the modified file as a User Commands file by adding the **.ucd* file extension.

## 8.11 RF cable delay and loss file

***Notes**:*

***1)** The file …\system data\UUT_cable_data.xml is not a default file; you must create it using the file name and format as shown*

***2)** GSS9000-series, GSS8000-series, GSS7000 and GSS7700 Variant B signal generators (both GSSS8000-series and GSS77xx signal generators need firmware version 1.24 onward) support this file*

***3)** Currently, this file supports only GPS and GLONASS frequencies*

The optional file …*system data\UUT_cable_data.xml*, provides any combination of RF loss and RF delay data (at GPS frequencies L1, L2 and L5) for the cable(s) connecting your single- or dual-output signal generator to the receiver under test. It also provides a delay value for the cable connecting your system to the signal generator's 1PPS rear-panel connector

If the file is not present (SimGEN's default), SimGEN uses 0 dB RF loss at all frequencies and 0 ns delay for all RF cables and 0 ns delay for the 1PPS timing cable.

The file must use this format:

```
<?xml version="1.0"?>
<!---COMMENT--->
<UUT_cable_data>
  <cable_ident> </cable_ident>
  <box_ser_no> </box_ser_no>
  <box_op>  </box_op>
  <output> normal </output>
  <delay_L1> </delay_L1>
  <loss_L1>  </loss_L1>
  <delay_L2> </delay_L2>
  <loss_L2>  </loss_L2>
  <delay_L5> </delay_L5>
  <loss_L5>  </loss_L5>
  <one_PPS_cable_delay_ns>  </one_PPS_cable_delay_ns>
</UUT_cable_data>
```

If you use a dual-output signal generator, repeat parameters `<cable_ident>` to `<loss_L5>` after `<loss_L5>`, so that `<one_PPS_cable_delay_ns>` is the last parameter.

Definition of parameters:

| | |
|---|---|
| `! [text]` | Free text comment |
| `cable_ident` | Free text description of cable |
| `box_ser_no` | Signal generator serial number<br>If you do not enter `box_ser_no`, SimGEN uses "0000" |
| `box_op` | RF output connector, numbered from 0<br>If you do not enter `box_op` SimGEN uses "0" |


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| | |
|---|---|
| `output` | Use “normal” unless Spirent advises you use an alternative |
| `delay_L1,delay_L2, delay_L5` | RF delay at each (GPS) frequency L1, L2, L5<br>Set unused frequencies to 0 nanoseconds<br>Units: nanoseconds Range: -3 000.0 to 3 000.0 ns |
| `loss_L1,loss_L2, loss_L5` | RF loss at each (GPS) frequency L1, L2, L5<br>Set unused frequencies to 0 dB<br>Units: dB Range: -10.00 to 10.00 dB |
| `one_PPS_cable_delay_ns` | Delay present in the cable connected to 1PPS rear-panel connector.<br>The signal generator adds this delay to the signal delay.<br>If unused, set to 0 ns<br>Units: nanoseconds Range: -3 000.0 to 3 000.0 ns |

Example files:

1) *UUT_cable_data.xml* - a file for a single-output signal generator using GPS L1 without a 1PPS timing cable

```
<?xml version="1.0"?>
<! Single-output GPS signal generator using L1 only>
<! and no 1PPS cable >

<UUT_cable_data>
  <cable_ident> RF cable </cable_ident>
  <box_ser_no> 1234 </box_ser_no>
  <box_op>   0  </box_op>
  <output>   normal  </output>
  <delay_L1> 1.2   </delay_L1>
  <loss_L1>  2.2   </loss_L1>
  <delay_L2> 0  </delay_L2>
  <loss_L2>  0  </loss_L2>
  <delay_L5> 0  </delay_L5>
  <loss_L5>  0  </loss_L5>
  <one_PPS_cable_delay_ns>   0  </one_PPS_cable_delay_ns>
</UUT_cable_data>
```

2) *UUT_cable_data.xml* - a file for a dual-output signal generator using GPS L1, L2 and L5 with a 1PPS timing cable

```
<?xml version="1.0"?>
<! Dual-output GPS signal generator using L1, L2 and L5>
<!and 1PPS cable >

<UUT_cable_data>
  <cable_ident> RF cable 1 </cable_ident>
  <box_ser_no> 1234 </box_ser_no>
  <box_op>   0  </box_op>
  <output>   normal  </output>
  <delay_L1> 1.2   </delay_L1>
  <loss_L1>  2.2   </loss_L1>
  <delay_L2> 3.2   </delay_L2>
  <loss_L2>  4.2   </loss_L2>
  <delay_L5> 5.2   </delay_L5>
  <loss_L5>  6.2   </loss_L5>

  <cable_ident>RF cable 2 </cable_ident>
  <box_ser_no> 1234 </box_ser_no>
  <box_op>   1  </box_op>
  <output>   normal  </output>
  <delay_L1> 1.3   </delay_L1>
  <loss_L1>  2.3   </loss_L1>
  <delay_L2> 3.3   </delay_L2>
  <loss_L2>  4.3   </loss_L2>
  <delay_L5> 5.3   </delay_L5>
  <loss_L5>  6.3   </loss_L5>
  <one_PPS_cable_delay_ns>   99.1 </one_PPS_cable_delay_ns>

</UUT_cable_data>
```


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# 9 Atmosphere file

The areas of the atmosphere known as the Ionosphere and (unless the receiver is in a spacecraft) the Troposphere delay the RF signal from each GNSS satellite to the receiver. For the receiver to calculate the true range to each satellite, and hence its own position, it must allow for these delays. There are various ways to do this:

- Delays are proportional to frequency. For a GPS L1 + L2 dual-frequency receiver, you can measure the different delays and calculate the absolute delay at each frequency. However, this is not applicable to single frequency (such as GPS L1-only) receivers, or GPS L1-only signal generators.
- The satellite Navigation data message broadcasts approximate Ionospheric corrections.
- The receiver uses a model to calculate approximate Tropospheric delay.
- A second receiver at a fixed location near your receiver may (using its known position and its GPS-derived position) calculate local values for Tropospheric and Ionospheric delay. The second receiver passes the local values to your receiver as “Differential Corrections”, for example ***RTCM differential corrections (GPMSG)*** (page 8-13)
- Some GNSS receivers allow you to specify the model to use, or to turn off modelling. Matching the receiver’s setting to the simulation should produce the most accurate navigation solution.

The atmosphere file (**.atm*) defines the characteristics of SimGEN’s simulated Ionosphere and Troposphere, and defines the Ionospheric data included in the Navigation Data message. Edit the atmosphere file in a similar way to editing the constellation file.

SimGEN uses these ionospheric models:

- NeQuick - default model for Galileo
- GPS/Klobuchar - applies to all other constellations, except IRNSS (Galileo can also use this model)
- IRNSS - a Klobuchar model where coefficients are applicable at L5, or a grid model

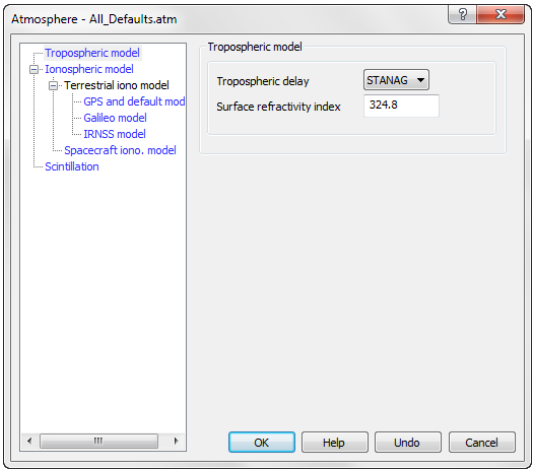
The default settings for the Klobuchar data are the same in all cases and correspond to fairly benign conditions.

SimGEN creates a default atmosphere file, *default_vx-yy.atm*. If you change any file parameter, you can save the file and apply a new filename.

***Copy*** (page 10-5) details the **Copy**, **All**, **Undo**, **OK**, **Help** and **Cancel** buttons.

## 9.1 Tropospheric model

Set the tropospheric model details for your scenario using the **Tropospheric model** dialog:



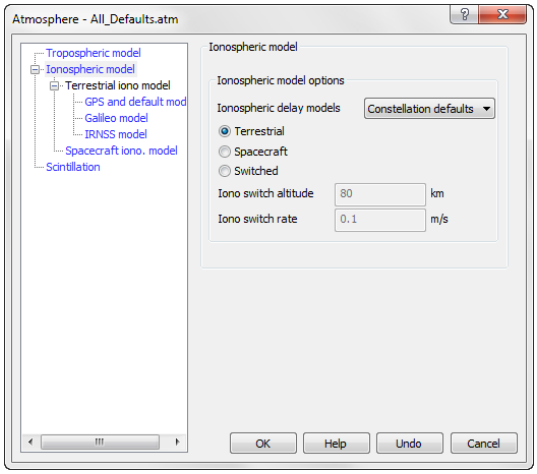


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| | | | |
|---|---|---|---|
| **Tropospheric delay** | Specifies the model SimGEN uses to calculate Tropospheric delay.<br>Using the same Tropospheric model as your receiver will give the best receiver accuracy. Choose from: | | |
| **STANAG** | (default) The Tropospheric model in reference a)<br>Enables Surface refractivity index | | |
| **Disabled** | Sets **Tropospheric delay** to 0 | | |
| **BD2** | The Tropospheric model in hh) | | |
| **RTCA96** | The Tropospheric model in reference l) | | |
| **RTCA98** | The Tropospheric model in reference m) | | |
| **RTCA06** | The Tropospheric model in reference p) | | |
| ***Note**: This model, with a few simplifications and changes in terminology, is effectively the same as the University of New Brunswick tropospheric model UNB3 (the recommended version for terrestrial applications).<br>The values of the relevant meteorological parameters in reference p) are identical to those for UNB3.* | | | |
| **Surface refractivity index at Mean Sea Level.**<br>(only used with the **STANAG** model) | Units: none | Range: 220 to 420 | Default: 324.8 |

## 9.2 Ionospheric model

Set the ionospheric model details for your scenario using the **Ionospheric model** dialog:




| | |
|---|---|
| **Ionospheric model options** | Choose how SimGEN calculates Ionospheric delay and choose the model for spacecraft that are within or above the Ionosphere. |
| **Ionospheric delay models** | Choose the model to use from: |
| **Constellation defaults** | (default)<br>Uses the default Ionospheric model for each constellation type, as follows:<br>GPS: Standard GPS model, you must select either **Terrestrial iono model-GPS and default model** or **Spacecraft iono. model**.<br>GLONASS, BeiDou, QZSS, SBAS: as GPS<br>Galileo: NeQuick<br>IRNSS and GAGAN: you must select **Terrestrial iono model-IRNSS model** |



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| | | | |
|---|---|---|---|
| **Fixed** | SimGEN applies a constant delay, defines as follows:<br>GPS: for individual satellites in terms of L1/L2 delay<br>GLONASS: in terms of L1 delay<br>Galileo: in terms of E1 delay<br><br>SimGEN determines the appropriate delay for each satellite frequency. | | |
| **Off** | Set to zero for all satellites and all frequencies | | |
| **GPS in all cases** | Use the GPS method for all constellations (including **Galileo** and **IRNSS**) | | |
| **Ionospheric model options** | SimGEN provides an alternative to the standard GPS Ionospheric model for spacecraft that are within or above the Ionosphere. Choose from: | | |
| **Terrestrial** | SimGEN uses the standard GPS Ionospheric model, reference b), to determine the Ionospheric delay throughout the scenario.<br>See ***Terrestrial iono model - GPS and default model*** (page 9-3) | | |
| **Spacecraft** | SimGEN uses an Ionospheric model throughout the scenario. This model takes into account the reduction in the ionization level (Total Electron Count) with increasing height in the Ionospheric layer.<br>See ***Spacecraft iono model*** (page 9-10) | | |
| **Switched** | Enables automatic switching between the **Terrestrial** model and the **Spacecraft** model (and back again) on passing through a height you specify in **Iono switch altitude**. | | |
| **Iono switch altitude** | The altitude you switch from using the **Terrestrial** model to using the **Spacecraft** model.<br>This altitude is nominally the lower edge of the Ionospheric layer. | | |
| | Units: kilometre | Range: 80 to 10 000 km | Default: 80 |
| ***Notes***:<br>***1)*** *Spirent uses* ***Iono switch altitude*** *because the Klobuchar model is not applicable at altitudes within, or above, the Ionosphere. Ideally, the Klobuchar model coefficients provide good agreement for the calculated delay between the* ***Terrestrial*** *and* ***Spacecraft*** *models. In practice, however, this is difficult to achieve.*<br>***2)*** *Galileo's NeQuick model is valid at all heights and does not need switching.* | | | |
| **Iono switch rate** | Prevents a sudden jump in pseudorange by controlling the transition from the **Terrestrial** model to the **Spacecraft** model | | |
| | Units: metres per second | Range: 0.001 to 50 $m.s^{-1}$ | Default: 0.1 |

## 9.2.1 Terrestrial iono model - GPS and default model

***Notes***:

***1)****These parameters apply only when you use the Klobuchar (GPS) model to model ionospheric delay*

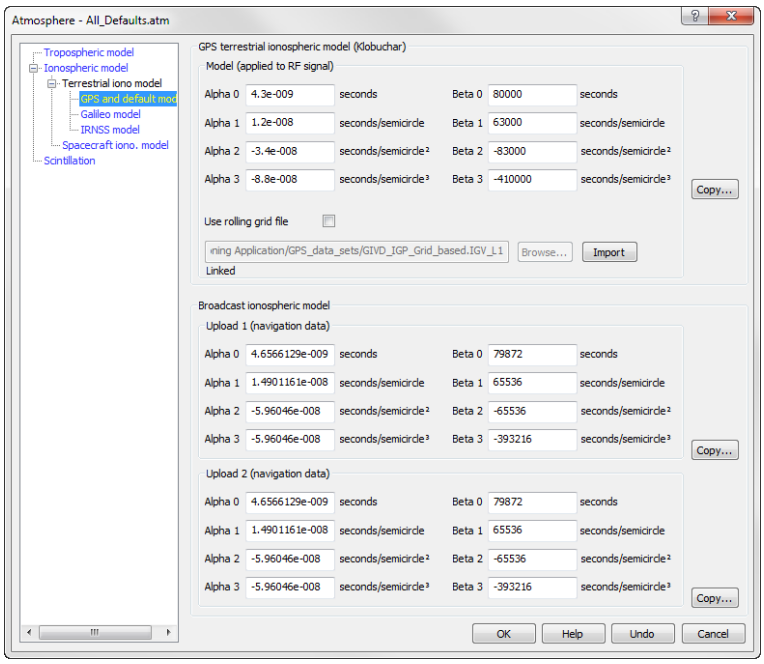
***2)*** *Currently, SimGEN uses the same basic code to generate the Klobuchar coefficients dialog for GPS (this section), and for IRNSS, see* ***Terrestrial iono model - IRNSS model*** *(page 9-7).*
*To see the Help file topic for the IRNSS Klobuchar model, Spirent recommend you select the Help topic you want to view from the SimGEN* ***Help-Contents*** *tab; clicking* ***Help*** *or pressing F1 on your keyboard may display an invalid Help topic.*

***3)*** *Currently,* ***GPS and default model*** *applies to all constellations (except IRNSS and Galileo) irrespective of whether you are using the Klobuchar model or a rolling grid file.*

***4)*** *SimGEN applies the ionospheric delay to the simulated RF output of GPS, SBAS and other satellites (except IRNSS and Galileo) when you select* ***Use rolling grid file****.*
*(Select* ***Terrestrial iono model - IRNSS model****-****Use rolling grid file*** *(page 9-7) to affect the RF output of IRNSS satellites)*

This figure shows the dialog you use to enter coefficients for the Klobuchar (GPS) terrestrial Ionospheric model.


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| | |
|---|---|
| **Model (Applied to RF signal)** | Calculate Ionospheric delay using the Klobuchar model, using coefficients **Alpha 0** to **Alpha 3** and **Beta 0** to **Beta 3**<br>SimGEN applies the calculated delay to the signal generator RF signal.<br>In the default data, the Model coefficients are set to typical values |



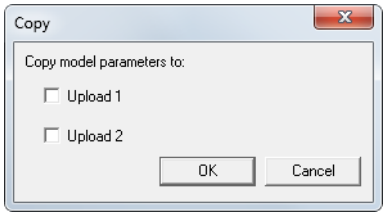
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| | |
|---|---|
| **Use rolling grid file** | Deselect: (Default) Uses the rolling grid file you select in **<SBAS constellation>-*Ionosphere - Error data*-Use rolling grid file** (page 10-48)<br>Select: Disables coefficients **Alpha 0** to **Alpha 3** and **Beta 0** to **Beta 3**<br>Uses the grid-based ionospheric model to calculate ionospheric delays according to the rolling grid file you select.<br>By default this area shows the location of the default grid data file *…/GPS_data_sets/GIVD_IGP_Grid_based.IGV_<frequency>*<br>that Spirent provides; where *<frequency>* indicates the frequency of the ionospheric delay, as follows:<br>1) **.IGV_L1* (and **.IGV*) is a data file with delay values with respect to L1.<br>When the rolling grid file provides ionospheric delays with respect to L1 for a satellite broadcasting on L2 or L5, SimGEN scales the ionospheric delays to L2 or L5 and then applies the delay values to the pseudorange.<br>2) **.IGV_L2* is a data file with delay values with respect to L2.<br>**.IGV_L5 is* a data file with delay values with respect to L5.<br>When the rolling grid file provides ionospheric delays with respect to a frequency other than L1, SimGEN first scales the delays to L1, then scales from L1 to the frequency the satellite is using and then applies the delay values to the pseudorange.<br><br>The files Spirent provides have the default locations:<br>C50r SimGEN Host: *D:\posapp\software\<version>\gui\GPS_data_sets*<br>SimGEN Controller:<br>*C:\Program Files\Spirent Communications\Positioning Application \GPS_data_sets*<br><br>Click **Browse…** to navigate to an “external” rolling grid file you want to use. The location of this file can be any folder on your C50r SimGEN Host or SimGEN Controller.<br>The text “Linked” shows SimGEN links the file shown to the scenario.<br>Click **Import** to navigate to a rolling grid file, as when clicking **Browse…** However, when you click **Open** in the dialog and select a file, SimGEN will import this file into the same folder as the file referencing it. This may be a scenario file (**.scn*) or the ‘shared’ folder; but, it is more likely to be a scenario source file, such as the atmosphere file (**.atm*) here. SimGEN automatically updates the path to the file.<br>The text “Importing” shows SimGEN will import the rolling grid file you select, rather than referencing the file from its original location.<br>Notice SimGEN completes the import of the file when you click **OK** and save the new atmosphere file to a name of your choice.<br>Subsequently, when you open this atmosphere file, the rolling grid file you selected appears in the text area without a pathname, since it is present in the scenario folder.<br>The text “Linked” shows SimGEN links the file shown to the scenario. |
| ***Note**:*<br>***1)** Spirent uses the following frequencies as the “base frequency” for the ionospheric data file:*<br>*GPS and all constellations except IRNSS: L1*<br>*IRNSS: L5*<br>***2)** Selecting **Use rolling grid file** will apply the rolling grid file you select to all constellations except Galileo and IRNSS* | |
| **Broadcast ionospheric model** | |
| **Upload 1 (navigation Data)** | For the navigation message that is current at the start of the simulation, this provides coefficients **Alpha 0** to **Alpha 3** and **Beta 0** to **Beta 3**.<br>Set the time of **Upload 1** in **Signal control-Upload details-L1/L2 delay**, see, for example, **GPS-*Signal Control - Upload details*** (page 10-48) |
| **Upload 2 (navigation Data)** | For the navigation message in use after Upload 2, this provides coefficients **Alpha 0** to **Alpha 3** and **Beta 0** to **Beta 3**.<br>Set the time of **Upload 2** in **Signal control-Upload details-L1/L2 delay**, see, for example, **GPS-*Signal Control - Upload details*** |


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***Notes**:*
***1)** There will be an error in the receiver's navigation data if the Model coefficients differ from the Upload1 and Upload 2 coefficients.*
***2)** SimGEN truncates the Upload data on entry to the resolution supported by the size of the navigation data fields. If you want the values to match exactly, you must set each Model coefficient to be equal to the coefficient of the same name, in each of the two Upload fields.*

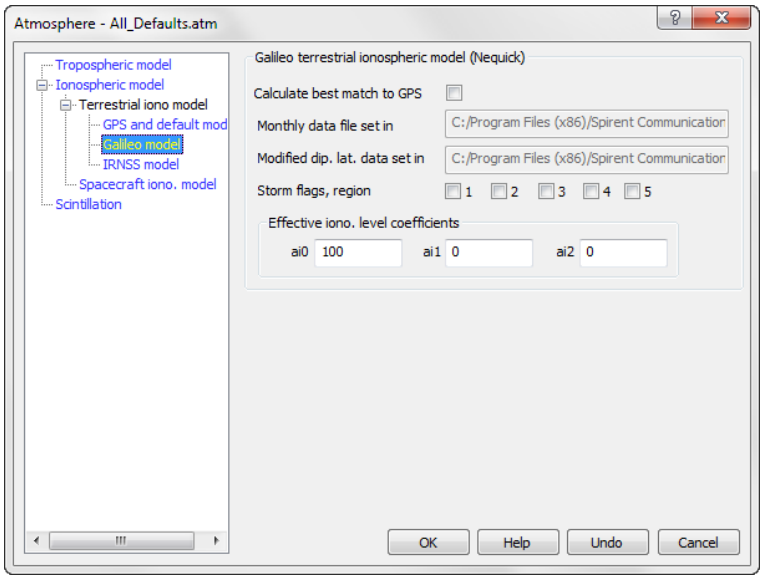
Click **Copy** to transfer coefficient values from the Copy button area to the areas you select in the **Copy** dialog. For example, clicking **Copy** in the **Model (applied to RF signal)** area opens this dialog:




Selecting **Upload 1** copies all **Model** coefficients to the **Upload 1** coefficients.

## 9.2.2 Terrestrial iono model - Galileo model

Galileo uses the Nequick model for modelling the ionosphere, see this dialog:




| | |
|---|---|
| **Calculate best match to GPS** | Not selected (default): Does not calculate best match to GPS<br>Select: SimGEN automatically determines ionisation coefficients for the NeQuick model using Klobuchar model coefficients.<br>The general range of ionospheric delay that SimGEN calculates using the NeQuick model for Galileo satellites will be similar to the delay SimGEN determines using the currently-defined Klobuchar model coefficients for GPS satellites. |

***Notes**:*
***1)** Spirent recommends you enter appropriate Klobuchar coefficients according to the scenario start date in the **Terrestrial iono model - GPS and default model** (page 9-3) dialog*
***2)** The accuracy of the 'best match' process is limited, particularly at times of low ionospheric activity when the NeQuick model may give low or zero ionisation levels but the related delays are still significant*


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| | | | |
|---|---|---|---|
| **Monthly data file set in** | The location of the set of twelve, monthly, ITU-R map files (the monthly data file set) used by the Galileo ionospheric model (Nequick). These files are located in the folder *C:\Program Files\Spirent Communications\Positioning Application \Galileo_data_sets*<br>If you replace the default files with alternatives, you must retain the appropriate name. Spirent recommends you copy any files before editing and you retain the original files in the folder *C:\Program Files\Spirent Communications\Positioning Application\Galileo Datafiles Backup*. | | |
| **Modified Dip Lat. data set in** | The Galileo ionospheric model (Nequick) needs a modified Dip Lat. data set. The files are located in the folder *C:\Program Files\Spirent Communications\Positioning Application \Galileo_data_sets*<br>If you replace the default files with alternatives, you must retain the appropriate name. Spirent recommends you copy any files before editing and you retain the original files in the folder *C:\Program Files\Spirent Communications\Positioning Application\Galileo\Datafiles Backup*. | | |
| **Storm flags, region** | SimGEN inserts a flag into the Navigation Data message for each Storm flag you select.<br><br>For each region **1** to **5**:<br>Not selected (default): Does not set **Storm flag** in the Navigation Data message for that region<br>Select: Sets **Storm flag** in the Navigation Data message for that region. | | |
| ***Note**: **Storm Flags** do not affect the Nequick ionospheric model* | | | |
| **Effective iono. level coefficients** | SimGEN inserts the values of coefficients **ai0** to **ai2** into the Navigation Data message.<br>Modelling Galileo ionospheric delay by selecting ***Terrestrial iono model - Galileo model*-Constellation defaults** (page 9-6) uses the coefficients **ai0** to **ai2** to determine the effective ionization level at the receiver position as a function of the modified dip latitude. SimGEN uses this level in the NeQuick model to calculate the ionospheric delay for the simulated Galileo satellite. | | |
| **ai0**,<br>**ai1**,<br>**ai2** | Units: none | Range:<br>**ai0**: 0 to 511.75<br>**ai1**: -4 to 4<br>**ai2**: -0.25 to 0.25 | Default:<br>**ai0**: 100<br>**ai1**: 0<br>**ai2**: 0 |

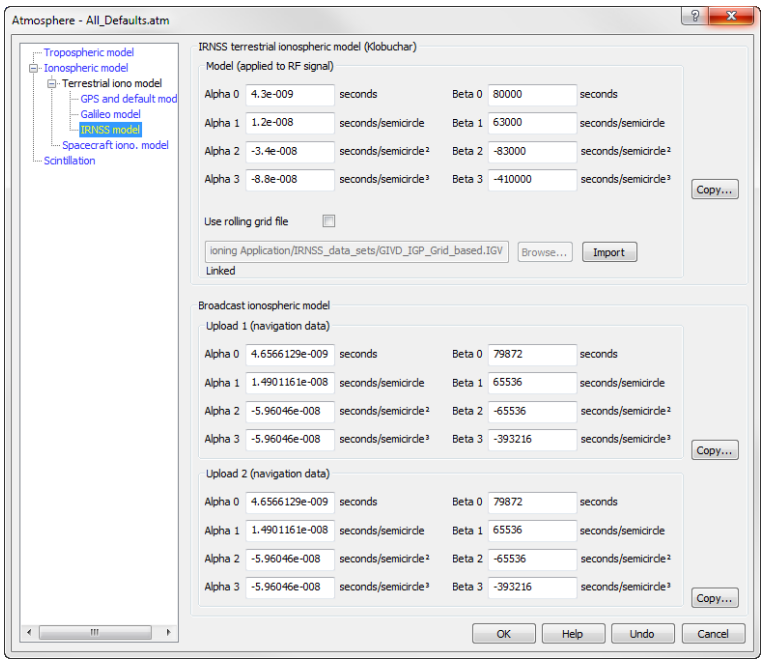
### 9.2.3 Terrestrial iono model - IRNSS model

***Note** SimGEN applies the ionospheric delay to the simulated RF output and its pseudorange when you select **Use rolling grid file**.*
*Selecting **Terrestrial iono model - IRNSS model-Use rolling grid file** only affects the RF output of IRNSS satellites.*
*(Select **Terrestrial iono model - GPS and default model-Use rolling grid file** (page 9-3) to affect the RF output of GPS, SBAS and other satellites)*

By default, IRNSS uses the Klobuchar model and an Ionospheric Grid Point mask file to determine ionospheric delay, see **IRNSS constellation editor-Navigation Data-*General*** (page 16-5).

SimGEN applies the Klobuchar coefficients directly at L5 (rather than L1 the standard for the GPS Klobuchar model). SimGEN provides a separate Klobuchar dialog for IRNSS (see the figure below) that you use in the same way as the ***Terrestrial iono model - GPS and default model*** (page 9-3).


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| | |
|---|---|
| **Use rolling grid file** | An alternative to using the IRNSS Ionospheric Grid Point mask file using a file containing a series of time-dependant values for GIVD (vertical ionospheric delay in metres) and GIVEI (the error index) at specific locations.<br>Deselect (default): uses the IRNSS Klobuchar model to determine Ionospheric delay and GIVEI, see **IRNSS constellation editor-Navigation Data-*General*** (page 16-5)<br>Select: Disables coefficients **Alpha 0** to **Alpha 3** and **Beta 0** to **Beta 3**<br>Uses the grid-based ionospheric model to calculate ionospheric delays according to the rolling grid file you select.<br>By default this area shows the location of the default grid data file *GIVD_IGP_Grid_based.IGV_<frequency>*<br>that Spirent provides; where *<frequency>* indicates the frequency the ionospheric delay, as follows:<br>1) **.IGV_L5* (and **.IGV*) is a data file with delay values with respect to L5. When the rolling grid file provides ionospheric delays with respect to L5 for a satellite broadcasting on S-band, SimGEN scales the ionospheric delays to S-band before applying the delay values to the pseudorange.<br>2) **.IGV_S* is a data file with delay values with respect to S-band. When the rolling grid file provides ionospheric delays with respect to S-band, SimGEN scales the delays to L5 before applying the delay values to the pseudorange.<br><br>The default grid data file has these default locations:<br>C50r SimGEN Host: *D:\posapp\software\<version>\gui\IRNSS_data_sets*<br>SimGEN Controller: *C:\Program Files\Spirent Communications\Positioning Application\IRNSS_data_sets*<br><br>***Rolling grid iono file format*** (page 9-9) describes the file format.<br><br>Click **Browse…** to navigate to an “external” rolling grid file you want to use. The location of this file can be any folder on your C50r SimGEN Host or SimGEN Controller.<br>The text “Linked” shows SimGEN links the file shown to the scenario.<br>Click **Import** to navigate to a rolling grid file, as when clicking **Browse…** However, when you click **Open** in the dialog and select a file, SimGEN will import this file into the same folder as the file referencing it. This may be a scenario file (**.scn*) or the ‘shared’ folder; but, it is more likely to be a scenario source file, such as the atmosphere file (**.atm*) here. SimGEN automatically updates the path to the file.<br>The text “Importing” shows SimGEN will import the rolling grid file you select, rather than referencing the file from its original location.<br>Notice SimGEN completes the import of the file when you click **OK** and save the new atmosphere file to a name of your choice.<br>Subsequently, when you open this atmosphere file, the rolling grid file you selected appears in the text area without a pathname, since it is present in the scenario folder.<br>The text “Linked” shows SimGEN links the file shown to the scenario. |

***Notes**:*

***1)** Selecting **Use rolling grid file** applies the ionospheric delay only to the navigation data message*

***2)** For the IRNSS constellation, the navigation data message always broadcasts ionospheric delays with respect to L5*

#### 9.2.3.1 Rolling grid iono file format

***Notes**:*

***1)** SimGEN does not interpolate between the Time of Week data you specify in the grid iono file*

***2)** You must include all data for the length of your scenario in any grid iono file you create, SimGEN does not provide a real-time update capability for the data in the grid iono file.*

***3)** SimGEN will only read grid iono file data from a single file.*

Spirent supplies rolling grid ionospheric files that define a series of time-dependant values for GIVD (vertical ionospheric delay in metres) and GIVEI (the error index).


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The navigation data message broadcasts GIVD and GIVEI. The relevant delay is also present in the RF signal at the output port of the signal generator.

Each line of this file specifies the grid ionospheric parameters, as follows:

→ Time of week (integer, seconds) latitude (degrees, floating), longitude (degrees, floating), GIVD ionospheric delay (floating, metres), GIVEI (integer index number)

Where:

"!" at the start of a line indicates a comment.
A single space, or comma, separates each grid-point parameter.

There is no limit to the file size.

Example partial listing of an **.IGV* file:

```
! Example file
345617 10 60 1.375 12
345617 15 60 1.5 12
345617 20 60 1.5 12
345617 25 60 1.375 12
345617 30 60 1.25 12
345617 35 60 1 12
345617 40 60 0.875 12
345617 45 60 0.75 13
345617 0 65 0.5 13
345617 5 6 0.875 12
345617 10 65 1.25 12
345617 15 65 1.25 12
345617 20 65 1.25 12
345617 25 65 1.25 12
345617 30 65 1 12
345659 35 65 0.875 12
345659 40 65 0.75 12
345659 45 65 1 12
345659 -5 70 63.875 15
345659 0 70 0.375 12
345659 5 70 0.625 12
.
.
.
```

## 9.3 Spacecraft iono model

***Notes**:*

***1)** This section is not relevant for Galileo users.*
*For Galileo satellites, Spirent uses the NeQuick Ionospheric model that applies equally well to both terrestrial and space-borne receivers, see* ***Terrestrial iono model - Galileo model** (page 9-6)*

***2)** When you use the spacecraft Ionospheric model, the resulting delay is completely independent of the Ionospheric coefficients broadcast in the navigation data.*

***3)** Pseudorange calculations for GLONASS and SBAS satellite signals also use this mode of operation.*

***4)** The significant part of the Ionospheric region is typically within the altitude range 100 km to 1 000 km.*

The spacecraft Ionospheric model is an alternative to the Klobuchar Ionospheric model.

The spacecraft Ionospheric model determines (for vehicles within or above the Ionosphere) the delay due to the presence of stray electrons in the signal path. This model calculates delay using the Total Electron Count (TEC), defined as the total number of electrons integrated along the path from the receiver to the satellite. TEC varies with altitude as follows:

→ Below 100 km, the TEC should be more or less constant.

→ Within the range 100 km to 1000 km, the TEC should always be decreasing.

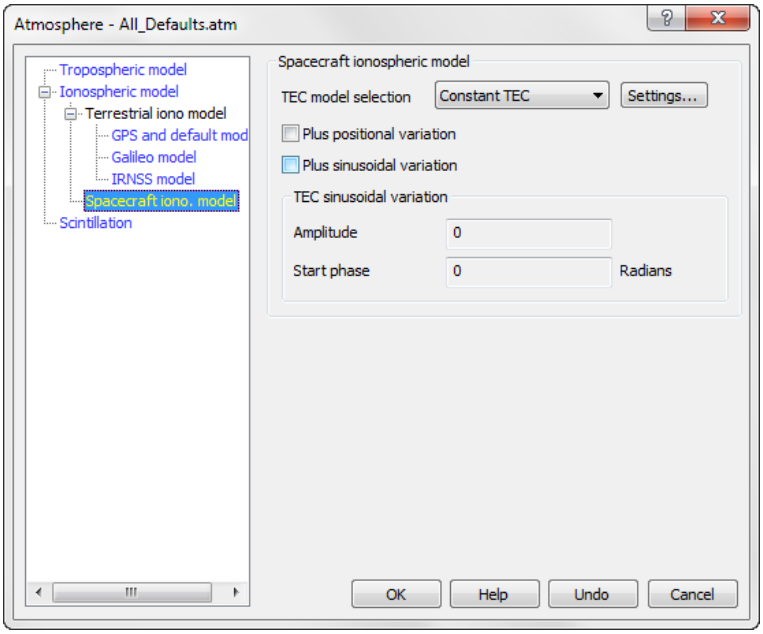
→ Above 1000 km, stray electrons are always present and the TEC is never zero.
Consequently, for altitudes exceeding 1000 km, this model will always calculate a delay.


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SimGEN applies the spacecraft Ionospheric model when you select **Atmosphere-Ionospheric model-Spacecraft or -Switched**. If you select **Switched** this model only applies when the vehicle is above the value of the parameter **Iono switch altitude**.

The spacecraft Ionospheric model lets you choose the TEC model and its settings.

This figure shows the **Spacecraft iono** model dialog.




SimGEN uses this equation to calculate Ionospheric delay, in metres:
***Note**: This equation only applies directly for positive elevation angles*

$$delay-ion=\frac{82.1\times TEC}{F_c^2\times\left[\sqrt{\left(\sin^2 E+0.076\right)}+\sin E\right]}$$

Where:

**TEC** = Total Electron Content above the space vehicle, electrons.m$^{-2}$

**$F_c$** = Carrier frequency, as appropriate

**E** = Elevation angle of satellite, with respect to the space vehicle

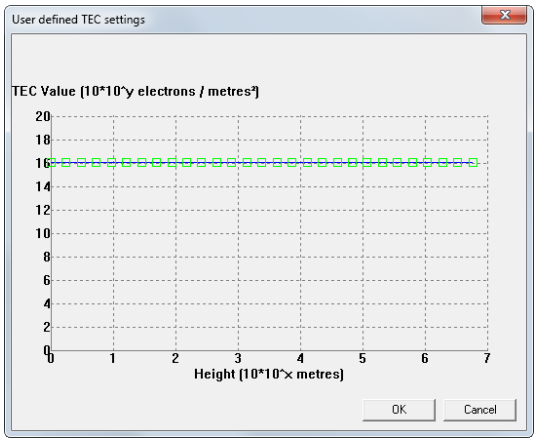
For negative satellite elevations, SimGEN determines the Ionospheric delay by assuming symmetrical deviation for signal paths that completely traverse the Ionosphere. SimGEN determines the net delay as the value that would apply in this case, minus the delay obtained for the corresponding positive elevation at the vehicle position. This also applies in the cases where the vehicle is above the Ionosphere, but the satellite signal comes through it.

Modelling TEC variation with height provides realistic results, particularly for negative satellite elevations. You can vary the TEC value with vehicle height and/or time by selecting one of the TEC models in **TEC model selection** and then clicking **Settings...** to enter the appropriate values:

| | | | |
|---|---|---|---|
| **TEC model selection** | Choose the model from the drop-down list, then click **Settings** to set the model parameters | | |
| **Constant TEC** | The TEC value remains constant throughout the run, regardless of changes in the vehicle height.<br>This model will not determine a realistic Ionospheric delay for satellites with negative elevations or with significant changes to the vehicle. | | |
| | Units: electrons per cubic metre | Range: 0 to 1 E+21 electron.m$^{-3}$ | Default: 1 E+17 |


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| | | | |
|---|---|---|---|
| **Polynomial TEC** | The following polynomial determines the TEC:<br>$TEC = TECr + C1.(\Delta h) + C2.(\Delta h)^2 + C3.(\Delta h)^3 + C4.(\Delta h)^4 + C5.(\Delta h)^5$<br>Where:<br>$\Delta h$ = vehicle (receiver) height - TEC reference Height<br>***Note**: SimGEN sets TEC=0 if the polynomial coefficients you specify result in a negative TEC for any vehicle height.* | | |
| **TEC reference Value TECr in polynomial** | Units: electrons per cubic metre | Range: 0 to 1 E+21 electron.$m^{-3}$ | Default: 1 E+17 |
| **TEC reference Height** | Units: metre | Range: 0 to 10 000 000 m | Default: 0 |
| **TEC polynomial coefficient 1 C1 in the polynomial** | Units: none | Range: ±1 E+19 | Default: 0 |
| **TEC polynomial coefficient 2 C2 in the polynomial** | Units: none | Range: ±1 E+16 | Default: 0 |
| **TEC polynomial coefficient 3 C3 in the polynomial** | Units: none | Range: ±1 E+11 | Default: 0 |
| **TEC polynomial coefficient 4 TEC polynomial coefficient 5 C4 and C5 in the polynomial** | Units: none | Range: ±1 E+6 | Default: 0 |
| **User Defined TEC** | Specify your own TEC profile using the graph of TEC value against height see the following figure. Define the TEC versus height relationship you want to use by dragging the points on the graph identified with green squares. | | |




| | |
|---|---|
| **Plus positional variation** | Modify the Ionospheric delay as a function of the Sun's position, relative to the path of the signal.<br>It introduces an element of day/night variation. |
| Selected | The model uses this formula:<br>Total TEC = TEC''( 1 + 0.143($U_{sun}$ • $U_{sv}$ ) )<br><br>Where:<br>TEC'' is the TEC value at the current height, determined as a constant value or a polynomial function of height, plus any sinusoidal variation.<br>$U_{sun}$ is a unit vector pointing towards the position of the Sun<br>$U_{sv}$ is a unit vector pointing towards the space vehicle |


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| | | | |
|---|---|---|---|
| ***Note***: *The vector dot* product ($U_{sun} \bullet U_{sv}$) *gives a result of +1 when the Sun is immediately above the vehicle, increasing the TEC by a factor of 0.143.*<br>*Conversely, when the vehicle is in the opposite direction to the Sun (in the Earth's shadow) the TEC reduces by a factor of 0.143.* | | | |
| Not selected | No modification of the Ionospheric delay | | |
| **Plus sinusoidal variation** | Modify the Ionospheric delay by adding a sinusoidal variation.<br>Enables **TEC sinusoidal variation -Amplitude** and **-Start phase** areas in this dialog (page 9-11) | | |
| Selected | The model uses the formula:<br><br>Total TEC = TEC' (1 + A cos( 2πt/T + Φ ) )<br><br>Where:<br>TEC' is the TEC value at the current height, determined as a constant value or a polynomial function of height.<br>A is the **Amplitude**<br>t is the current GPS time in seconds<br>T = 86,400 s (one day in seconds)<br>Φ is the **Start Phase** | | |
| **Amplitude** | Units: none | Range: 0 to 1 | Default: 0 |
| **Start phase** | Units: radians | Range: 0 to 2π rad | Default: 0 |
| Not selected | No modification of the Ionospheric delay | | |

## 9.4 Scintillation

***Notes**:*

***1)** Although you can use 100 milliseconds Simulation Iteration Rate when using the Scintillation model, Spirent recommends you use 1 millisecond Simulation Iteration Rate with GSS9000-series signal generators (and 10 milliseconds, or less, with all other signal generators) to give statistically better results. **General Options** (page 5-15) details setting the Simulation Iteration Rate.*

***2)** The Scintillation model applies to all constellations.*

***3)** The Scintillation model applies from SimGEN version 2-91 onwards. To maintain compatibility with SimGEN up to version 2-90, SimGEN disables the Scintillation model by default.*

***4)** The Cornell Ionospheric Scintillation Model, reference kk), provides the basis for Spirent's implementation of the Scintillation model. This model is only appropriate for equatorial scintillation and Spirent recommends you keep the values of **Scintillation index** in polar regions to their default values.*

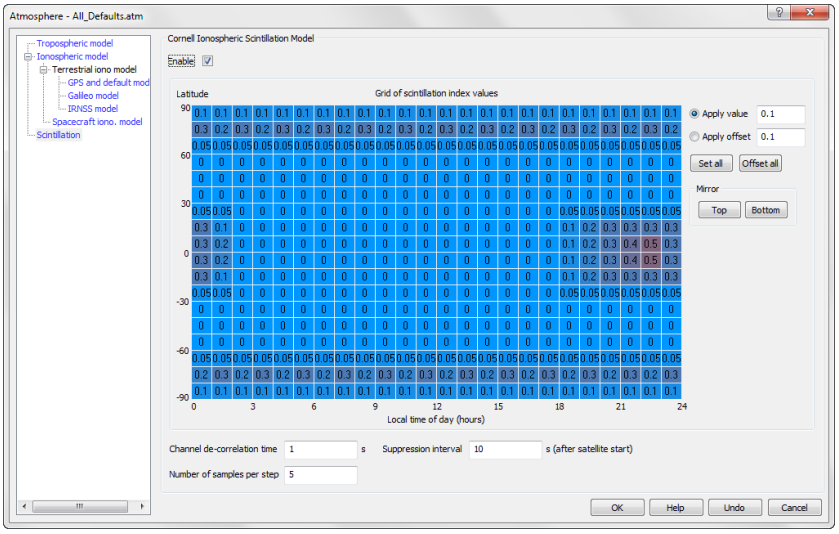
Scintillation is the fluctuation in phase and intensity of a GNSS signal as it passes through the Earth's atmosphere, particularly the ionosphere. It is an effect of electron density irregularities along the propagation path.

Severe scintillation can lead to navigation-bit errors, cycle slipping and complete loss of carrier lock in a GNSS receiver. For example, strong equatorial scintillation can lead to power fades greater than 15 dB, accompanied by abrupt, approximately half-cycle, phase transitions.

The values for **Scintillation index** and **Channel de-correlation time** ($S_4$ and $\tau_0$, respectively, in reference kk), the Cornell Ionospheric Scintillation model) primarily determine the characteristics of the signal offsets generated by the model (amplitude and rapidity of change).

To enter new values of **Scintillation index**, first select **Enable** and then type the value with reference to a grid of Latitude against local time of day, see the following figure:


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SimGEN's default grid settings represent a moderate level of scintillation activity, occurring after sunset.

To determine the value of **Scintillation index** to apply to a given satellite, SimGEN first determines the 'ionospheric pierce point' (the nominal point at which the signal from the satellite traverses the ionosphere, approximately 300 km above the Earth's surface). SimGEN then interpolates the appropriate **Scintillation index** from the values in the grid of Latitude and local time of day. Consequently, SimGEN applies different values of Scintillation index for each signal and, as the scenario progresses, these values will slowly vary.

For all signals, the value for $\tau_0$ remains fixed throughout the scenario.

| | | | |
|---|---|---|---|
| **Enable** | Deselect (default): Disables Scintillation model<br>Select: Enables Scintillation model | | |
| **Grid of scintillation index values** | This area shows values of scintillation index, S4 in reference kk), on a grid of Latitude (degrees) versus local time of day (hours).<br>Ranges taken from reference kk):<br>1) S4 < 0.4 indicates weak scintillation<br>2) S4 > 0.6 indicates strong scintillation<br>3) S4 ≈ 1 indicates saturation<br>4) Higher values of scintillation index (S4) with lower values of **Channel de-correlation time** (τ0) lead to more severe scintillation | | |
| **Apply value** | Set the **scintillation index** of a cell by first typing a value in **Apply value** and then clicking in that cell, or set a series of cells to that value by dragging the mouse | | |
| | Units: none | Range: 0 to 1 (in 0.01 steps) | Default: 0.1 |
| **Apply offset** | Offset the current **scintillation index** of a cell by first typing a value in **Apply offset** and then clicking in that cell, or offset a series of cells by dragging the mouse | | |
| | Units: none | Range: -1 to 1 (in 0.01 steps) | Default: 0.1 |
| **Set all** | Click to set all cell values to the value in **Apply value** | | |
| **Offset all** | Click to offset all cell values by the value in **Apply offset** | | |
| **Mirror** | Mirrors the cells about 0 degrees Latitude | | |
| **Top** | Copies the values of all cells in Latitude range 0 to -90 degrees to all cells in Latitude range 0 to +90 degrees | | |
| **Bottom** | Copies the values of all cells in Latitude range 0 to +90 degrees to all cells in Latitude range 0 to -90 degrees | | |
| **Channel de-correlation time** | Controls the scintillation response time, τ0 in reference kk) and remains fixed throughout the scenario.<br>Low values of τ0 indicate rapidly varying scintillation<br>High values of τ0 indicate slowly varying scintillation | | |



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| | | | |
|---|---|---|---|
| | Units: seconds | Range: 0.1 to 2 s | Default: 1 |
| **Number of samples per step** | Applies averaging depending on the setting in ***General Options***-**Simulation iteration rate** (page 5-15)<br>When you use lower values of **Simulation iteration rate**, a high **Number of samples per step** will give a less noisy result.<br>Spirent advises these settings for GSS7000 and GSS8000-series, and earlier, signal generators:<br>100 milliseconds (low) iteration rate - use 10 samples per step<br>10 milliseconds (high) iteration rate - use four samples per step<br>four milliseconds (high) iteration rate - use two samples per step<br><br>With GSS9000-series signal generators, Spirent advises you use one sample per step with one millisecond iteration rate | | |
| | Units: none | Range: 1 to 10 | Default: 5 |
| **Suppression interval** | Some GNSS receivers may not lock to the satellite signal if the scintillation model is active at the start of the scenario, or when the satellite rises during a scenario. To overcome this, SimGEN:<br>1) Suppresses application of the scintillation model for newly simulated satellites by the time you set in **Suppression interval**, then<br>2) Applies the scintillation model offsets gradually over a ramp-up time given by:<br>**Suppression interval** < 10 s: ramp time = **Suppression interval**<br>**Suppression interval** > 10 s: ramp time = 10 s | | |
| | Units: seconds | Range: 0 to 999 s | Default: 10 |


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# 10 GPS constellation editor

SimGEN version 2-83 SR02 onwards supports GPS L1C for GSS8000-series signal generators only when using signal generator card firmware version 2-12 (or later) and FPGA image release 25 (or later).

To use GPS L1C, you may need to upgrade the FPGA release and/or firmware version of each signal generator card installed in your signal generator. To find the firmware version and FPGA image of your signal generator cards and then determine if your signal generator needs upgrading, Spirent recommends you follow this procedure:

- See the menu item **Options-*Hardware Configuration*** (page 5-18), then display your signal generator configuration
- Select your signal generator
- Click **Output details…**
- Contact ***Spirent Global Services*** and provide the relevant details from the configuration window.
- Spirent Global Services will then determine if your signal generator needs upgrading and provide details on the upgrade procedure.

The **GPS constellation-GPS signal sources file** characterises the GPS satellites in a simulation. This file is often known as the “GPS Constellation file”, and is one of the source files defining a scenario. The default signal sources filename for the GPS constellation file is *default_vx-yy.gps*.

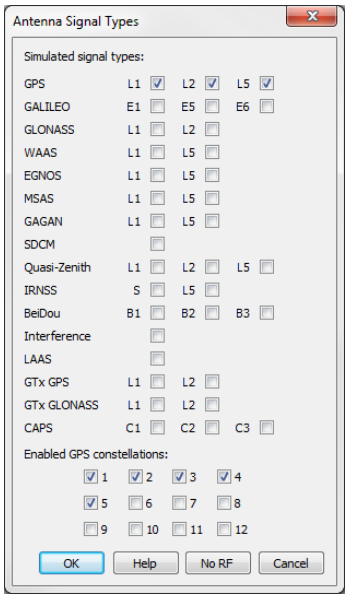
This table gives the reference power levels for GPS L1, L2 and L5.

| GPS frequency | Power reference level, dBm |
|---|---|
| L1 | -130.0 |
| L2 | -136.0 |
| L5 | -127.9 |

## 10.1 Multiple GPS Constellations

***Licenced feature**: You will need a licence to use this feature. Contact Spirent for licencing details.*

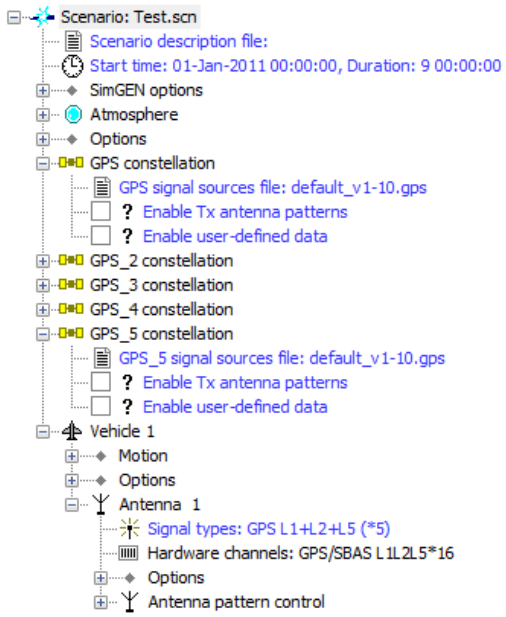
You can select up to 12 GPS constellations in the **Antenna Signal Types** dialog:




After selecting the number of **Enabled GPS constellations** you want to use, the **Scenario Contents** window displays a GPS constellation for each of your selections. The **Vehicle n-Antenna n-Signal types** shows the number of selected constellations, prepended with ‘*’.


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For example, this figure shows, for the five GPS constellations selected in the figure above, a separate GPS Constellation (**GPS constellation** to **GPS_5 constellation**) with **Signal types** as **GPSL1+L2+L5 (*5)**:




## 10.2 Extended GPS constellation

SimGEN 4.02 SR01 onwards supports the extended constellation (31 additional satellites) defined in ICD-GPS-200F, reference b). The extended constellation acts as an independent GPS constellation with the following restrictions:

- Satellites in the extended constellation do not broadcast the L2CNAV and L5NAV navigation data messages (see ***Navigation data errors*** and ***Navigation data modification***)
- Currently, Spirent does not support broadcasting L1 CNAV-2 navigation data messages by satellites in the extended constellation
- SBAS and LAAS constellations (see ***SBAS constellation editor*** (page 14-1) and ***GBAS constellation editor*** (page15-1)) do not support satellites in the extended constellation
- Satellites in the extended constellation do not support RTCM and NMEA messages (see ***RTCM run-time data display*** (page 8-18) and ***NMEA output*** (page 8-11))
- Quasi-Zenith satellites (see ***Quasi-Zenith constellation editor*** (page 13-1)) do not re-broadcast navigation data for satellites in the extended constellation
- ***PLTS and ULTS - NovAtel message emulation*** (page 5-23) does not support satellites in the extended constellation
- Satellites in the extended constellation currently only support broadcasting LNAV legacy navigation data.
- Spirent limits the PRN and SVID range to 1 to 32 for CNAV and (for authorised users) MNAV
- You cannot define satellites in the extended constellation with ***User-defined data*** (page 20-1) files
- Authorised users of MNAV / PPS will only see 32 satellites
- NMEA output file uses 33 to 65, although see reference eeee)

To use the additional satellites in the extended constellation, first select **GPS signal sources-*General*-Extended constellation**:

| GPS signal sources-General-Extended constellation | PRN and SVID range | Description |
|---|---|---|


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| GPS signal sources-General-Extended constellation | PRN and SVID range | Description |
|---|---|---|
| Deselected (default) | PRN: 1 to 32<br>SVID: 1 to 32 | “Lower PRN set” or “legacy” constellation<br>ICDs up to (and including) ICD-GPS-200E define the PRN and SVID |
| Selected | PRN: 1 to 32, 33 to 63<br>SVID: 1 to 32, 65 to 95 | “Upper PRN set” or “extended” constellation<br>ICDs from ICD-GPS-200F onward define the PRN and SVID |

Navigation data broadcast by satellites in the lower PRN set is unchanged.

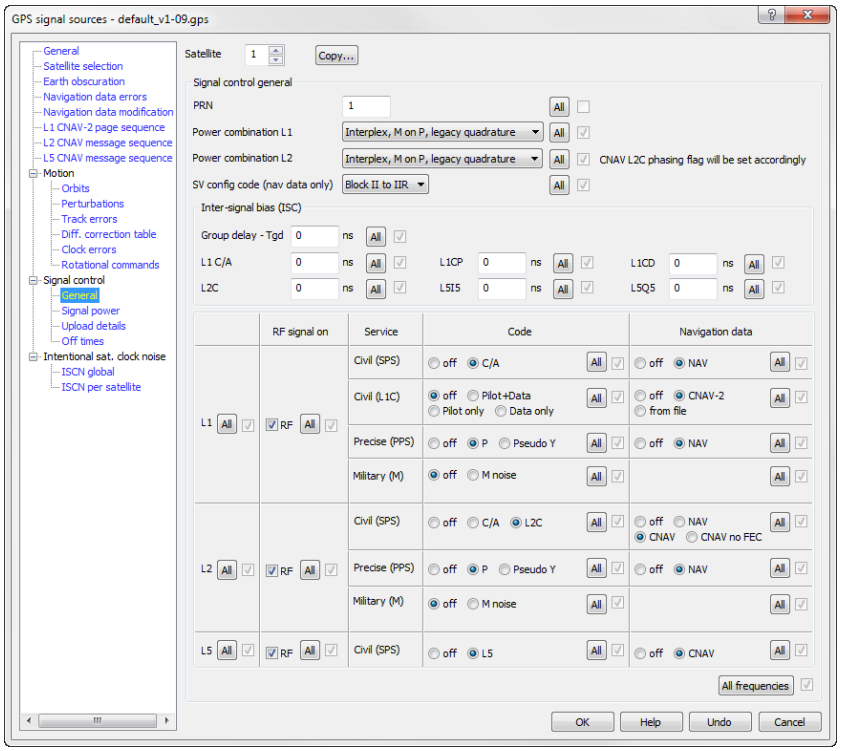
Normally, at least one satellite using a PRN in the upper PRN set serves as a source of almanac data for all satellites using the upper PRN set.

If you enable the extended constellation, SimGEN shows the additional satellites in windows such as ***Ground Track*** (page 3-12) and ***Sky Plot*** (page 3-4).

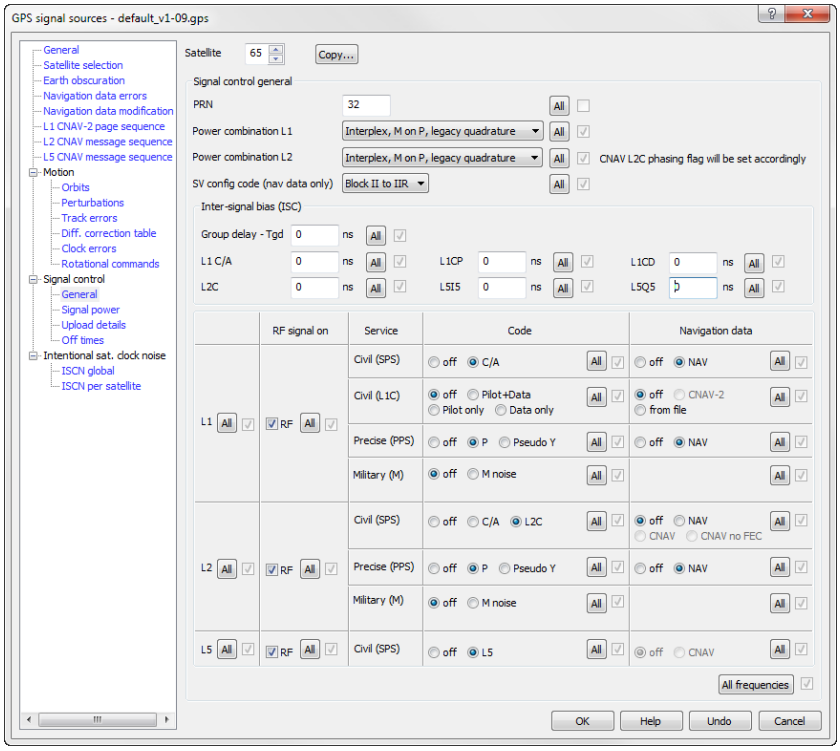
If you enable the extended constellation, you can use ***Accessing simulation (Quick-Look) data*** (page 25-1) to log data for satellites in the extended constellation.

### 10.2.1 Default settings for Signal control-General

**Satellite** range 1 to 32 uses the following defaults:



**Satellite** range 33 to 63 uses these defaults:




Notice **Navigation data-CNAV**, **-CNAV-2** and **-CNAV no FEC** and **L5-Navigation data** are disabled.

### 10.2.2 Settings for All

With the default setting for **GPS signal sources-*General*-Extended constellation** (deselected), SimGEN uses satellites in the lower PRN set (satellites 1 to 32). Selecting **All** for a parameter applies the parameter settings to all satellites in the lower PRN set.

After you select **GPS signal sources-*General*-Extended constellation**, selecting **All** for a parameter may no longer apply the parameter settings to every satellite in both the lower PRN set and the upper PRN set. When you use the extended constellation, selecting **All** for a parameter means selecting all satellites that can be enabled. The following table shows this subtle change:

| GPS signal sources-General-Extended constellation | L2 navigation data (see Signal Control - General) | Action on selecting All |
|---|---|---|
| Deselected (default) | select CNAV no FEC for satellite 1 | All satellites in the lower PRN set (1 to 32) use CNAV no FEC.<br>Tick present in **All** check box for satellites 1 to 32 |
| Selected | select CNAV no FEC for satellite 1 | All satellites in the lower PRN set (1 to 32) use CNAV no FEC.<br>Tick present in **All** check box for satellites 1 to 32<br><br>All satellites in the upper PRN set (33 to 63) cannot use CNAV no FEC, it is disabled.<br>Tick not present in **All** check box for satellites 33 to 63 |

## 10.3 GPS constellation editor

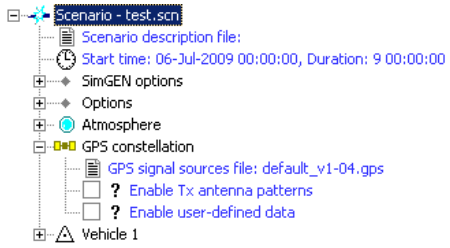
To use the GPS constellation, first see **Receive and transmit antennas-*Associate a GNSS signal with an antenna*** (page 23-4) and associate the appropriate signal with the antenna(s) you want to use.

Use the constellation editor to edit data in the GPS constellation file. The editor shows the data in the GPS constellation file as a series of “pages”. The left-hand area shows the pages you can select for editing; the right-hand area shows the details of the page you selected in the left-hand area. This section describes how you select and change details in the right-hand area.


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SimGEN checks the range of the value you type in a text box and, if incorrect, displays the range of acceptable values.

After associating the GPS signal type with an antenna, the GPS constellation file appears in the **Scenario contents** window:




**Receive and transmit antennas-*Transmitter antenna level and phase*** patterns (page 23-20) details creating and applying **Tx antenna patterns**.

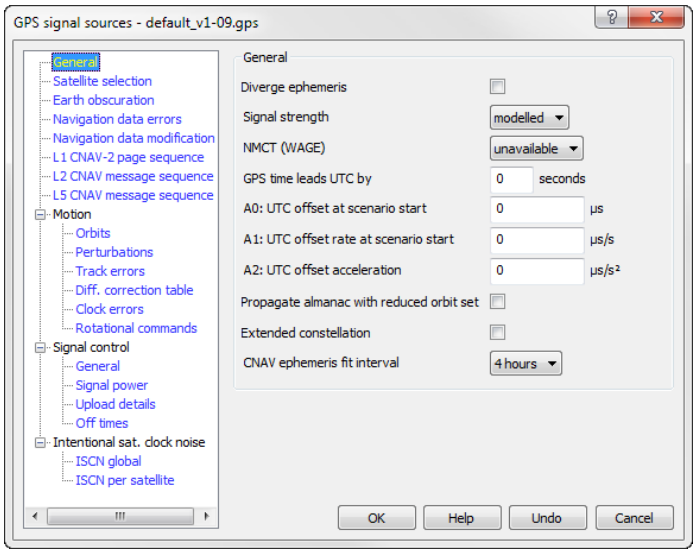
The chapter ***User-defined data*** (page 20-1) describes using **user-defined data** (currently, SimGEN supports **user-defined data** only with the GPS constellation).

To edit the GPS constellation file, work in the **Scenario contents** window. First, expand **GPS constellation**. Then:

→ Select **GPS constellation-Signal sources file**

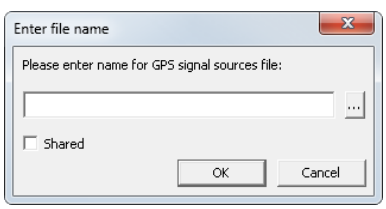
→ Right-click and select **Edit**

→ You will see the **Signal sources-General** dialog, shown below. The GPS signal sources file has the default name, *default_vx-yy.gps*.




→ The left-hand area of the **Signal sources** dialog shows the titles of all “pages” you can edit in the file. Click on a title to edit it.

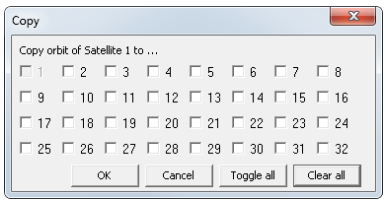
→ After editing the **Signal sources file**, click **OK** then save the file to a name of your choice using this dialog. Select **Shared** to save this file to the shared folder, so making it available to other scenarios.



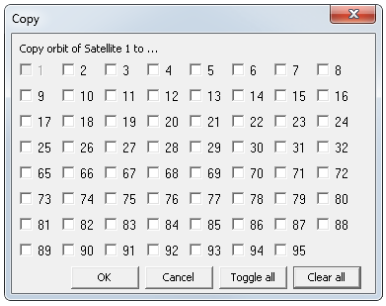

## 10.4 Copy

This table describes the **Copy** dialog buttons.

| Button | Description |
|---|---|
| **All** | ***Note**: The checkbox is an indicator only*<br>Applies the data entered for one satellite to all satellites.<br>A tick appears in the All checkbox to confirm this action |
| **Copy** | Copies data for a specific satellite to satellites you select in the Copy dialog see the figures below |
| **Toggle all** | Selects/deselects all satellites |
| **Clear all** | Clears selection for all satellites |
| **Undo** | Undoes your selections |
| **OK** | Applies selection |
| **Help** | Opens the Help file |
| **Cancel** | Closes the editor without applying your selections |

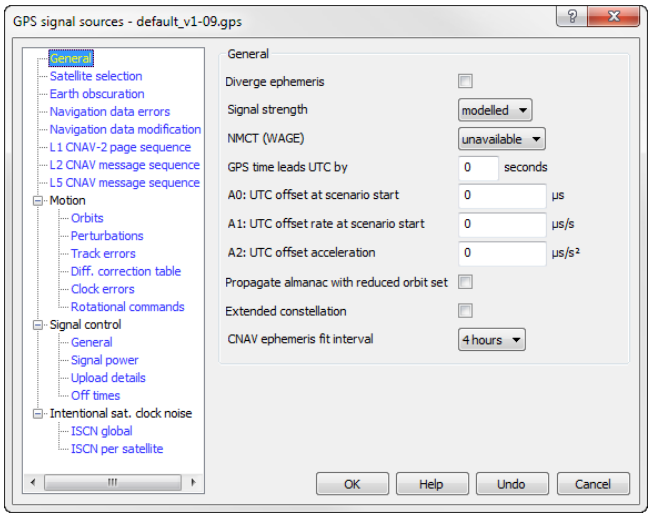



The extended constellation includes Satellites in the lower PRN range and upper PRN range :




## 10.5 General

Use this dialog to specify the following parameters that affect all GPS satellites.





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| | |
|---|---|
| **Diverge Ephemeris** | Deselect (default): The ephemeris transmitted in the navigation data for each satellite accurately describes the simulated satellite orbit<br>Select: Simulates degradation in ranging accuracy by applying errors to the ephemeris transmitted in the navigation data for each satellite. The degradation is in accordance with the Graceful Degradation of Accuracy curve in reference a) |
| ***Note***: *The position SimGEN simulates remains the position you specify in the constellation editor* | |
| **Signal strength** | Select whether SimGEN modifies satellite signal-levels based on satellite-to-antenna distance or uses a fixed signal level. **GPS-*General - Modelled and fixed signal strength*** (page 10-8) gives further details on **Modelled** and **Fixed**. In each case, first set the base RF power level using ***Signal Control - Signal Power*** (page 10-46)<br><br>Choose from: |
| **Modelled** | (default) SimGEN modifies satellite signal level as a function of the satellite to receiver antenna distance in proportion to $(\text{distance})^{-2}$ |
| **Fixed** | SimGEN does not modify the signal level as a function of satellite to receiver antenna distance |
| **NMCT (WAGE)** | choose from: |
| **Available** | Flags the NMCT data in the broadcast GPS navigation data message (Subframe 4, Page 13) as valid (unencrypted)<br>The information in the correction table is determined from any radial track error or clock error terms (such as Delta Af0, see ***Motion - Clock errors*** (page 10-37)) you specify for particular satellites<br>Updates occur during an upload for this satellite |
| **Unavailable** | Sets the AODO field in Subframe 2 to “invalid” (all 1’s), otherwise this indicates the age of the NMCT data for the transmitting satellite |
| ***Note***: *The reference time of the NMCT data is set as 15 minutes before the upload time and the initial value of AODO (subframe 2) is set accordingly (relative to the next ephemeris reference time). The correction table does not contain error data for the satellite broadcasting this information (this is implicitly zero) or for satellite 32. A receiver should apply the most recent set of WAGE correction data. If the latest reference time is the same for several satellites, the receiver can use any of these sets but there is then some ambiguity if non-zero errors apply for these satellites. The default selections for satellite upload times in the GPS Constellation file correspond with the scenario start time for all satellites, which does not facilitate the application of WAGE in this context. In order to obtain a more realistic situation the previous upload times for most satellites should be set to have occurred sometime before the start of the run (up to 24 hours say), with a few satellites (one of which should be visible at the start of the run) having uploads at, or just before, the start time. Subsequent upload times should also be set more realistically.* | |

| | | | |
|---|---|---|---|
| **GPS time leads UTC by** | Disabled unless you select ***Start time*-UTC offset control-Legacy (constellation file)** (page 4-15), to give compatibility with scenarios created up to SimGEN version 2-90. When enabled, you can specify the GPS (time) to UTC (Universal Time Co-ordinated) offset as an integer number of seconds<br>SimGEN always displays GPS time | | |
| | Units: seconds | Range: -128 to +127 s | Default: 0 |
| For example, you use a GPS to UTC offset of 12 seconds. When you connect a GPS receiver set to display UTC time, to your signal generator, you will see the receiver time display offset by 12 seconds from the simulation time | | | |
| **A0: UTC offset at scenario start** | Units: microseconds | Range: $\pm$100 $\mu$s | Default 0 |
| ***Note***: *You can specify this value when no leap second adjustment is scheduled.* | | | |
| **A1: UTC offset rate at scenario start** | Units: microseconds per second | Range: $\pm$0.0074 $\mu s.s^{-1}$ | Default: 0 |
| ***Note***: *You can specify this value when no leap second adjustment is scheduled.* | | | |
| **A2: UTC offset acceleration** | Units: microseconds per $(\text{second})^2$ | Range: -2.17 E-13 to 2.13 E-13 $\mu s.s^{-2}$ | Default: 0 |
| ***Note***: *You can specify this value when no leap second adjustment is scheduled.* | | | |


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| | |
|---|---|
| **Propagate almanac with reduced orbit set** | Deselect (default): SimGEN calculates the broadcast almanac using all orbital parameters<br>Select: SimGEN calculates the broadcast almanac using only terms in the orbital parameter set that are included in the almanac set. This means extrapolating the almanac back to the upload time gives good correspondence with the actual satellite motion at this time |
| **Extended constellation** | Deselect (default): SimGEN uses satellites 1 to 32 (the lower PRN range)<br>PRN range: 1 to 32, SVID range 1 to 32<br>Select: SimGEN uses satellites 1 to 32 and additional satellites in the extended constellation (the upper PRN range)<br>PRN range: 33 to 63, SVID range: 65 to 95 |
| ***Notes**:*<br>***1)** Satellites in the lower PRN range (legacy constellation) use the same range for PRN and SVID*<br>***2)** Satellites in the upper PRN range (extended constellation) use separate ranges for PRN and SVID* | |
| **CNAV ephemeris fit interval** | The fit-interval depends on the version of ICD. Before reference bb), the fit-interval was fixed at four hours for all navigation data messages.<br>The reference time for the ephemeris and clock data broadcast in the GPS navigation data messages is nominally at the mid-point of the fit-interval (however, be aware that reference times are offset slightly when an upload occurs).<br>Select the fit-interval from:<br>**3 hours**:<br>SimGEN version 5.04 onwards uses three hours as the fit-interval.<br>Reference bb) defines a fit-interval of three hours for CNAV and CNAV-2 navigation data messages.<br>The reference time is 1.5 hours after the cutover time for the current data-set, which starts on a 2 hourly epoch.<br>**4 hours**:<br>SimGEN up to version 5.03 used a fit-interval of four hours for all navigation data messages.<br>Select a four-hour fit interval for L1 C/A navigation data and for compatibility with ICD's before reference bb).<br>The reference time is nominally two hours after the cutover time. |

## 10.5.1 General - Modelled and fixed signal strength

SimGEN calculates the RF power level at the front panel output port of the signal generator; the calculation depends on your selection of **General-Signal Strength-modelled** or **-fixed** in SimGEN's constellation editor.

### 10.5.1.1 Modelled

SimGEN uses **Signal strength-Modelled** to provide your receiver with realistic signal levels by using these details:

- → The GNSS base level from the ICD
- → Signal and code level offsets
- → The inverse-square loss over the satellite to vehicle range
- → Losses from the transmit antenna pattern of the satellite
- → Losses from the antenna pattern of the receiver

in this equation:

$$P_O = P_{ICD} + O_G + O_F + O_S + 20*\log_{10}(R_0 / R) - L_{TX} - L_{RX} \quad \text{(dBm)}$$

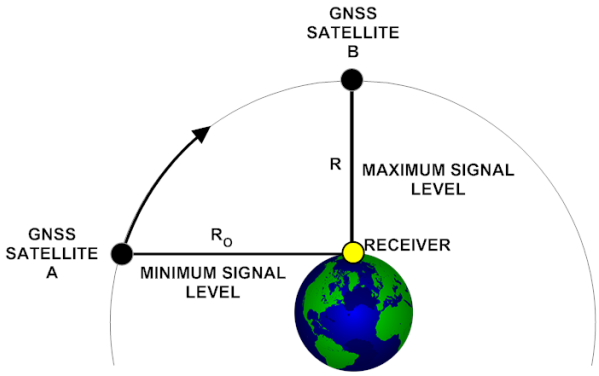
Where:

| | |
|---|---|
| $P_O$ | is the signal generator output power for a given satellite |
| $P_{ICD}$ | is the guaranteed minimum signal level for the GNSS satellite.<br>For example, reference b) specifies the level for GPS |
| $O_G$ | is the **Global Offset** set in the constellation editor's **Signal Control-Signal Power** dialog<br>For example, see **GPS-*Signal Control - Signal Power*-Signal power-Global Offset** (page 10-46) |


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| | |
|---|---|
| $O_F$ | is the frequency specific offset (if used) as entered in the constellation editor's **Signal Control-Signal Power** dialog<br>For example, see **GPS-*Signal Control - Signal Power*-L1 power-Global L1 Offset** |
| $O_S$ | is the signal specific offset (if used) as entered in the constellation editor's **Signal Control-Signal Power** dialog<br>For example, see **GPS-*Signal Control - Signal Power*-L1 power-C/A code Offset** |
| $R_0$ | is the reference range used for inverse-square variation calculation and equal to the range from a receiver on the ground to the GNSS satellite at zero elevation.<br>$R_0 = [(\text{satellite_orbital_radius})^2 - (\text{earth_radius})^2]^{1/2}$, see the figure below |
| R | is the range from GNSS satellite to the receiver, see the figure below<br>R = (satellite_orbital_radius) – (earth_radius) |
| $L_{TX}$ | is the loss from the GNSS satellite transmit antenna in the direction of the receiver.<br>***Transmitter antenna level and phase*** patterns (page 23-20) defines this loss |
| $L_{RX}$ | is the loss from the receiver antenna in the direction of the GNSS satellite.<br>***Antenna pattern*** (page 23-9) defines this loss. |

***Note**: SimGEN's transmit and receive antenna pattern files use the convention of a positive number representing attenuation so a positive number in the antenna pattern reduces the power level*




For example, the following table gives typical parameter values (and their sources) to show calculation of the simulated RF power from an overhead GPS satellite for a ground-based receiver using L1 C/A code:

| Parameter | Description | Value |
|---|---|---|
| $P_{ICD}$ | Guaranteed ICD minimum signal level for a GPS satellite<br>set satellite using **GPS-*Signal Control - Signal Power*-Satellite** | -130 dBm |
| $O_G$ | Global Offset, set by<br>**GPS-*Signal Control - Signal Power*-Signal power-Global Offset** | +15 dB |
| $O_F$ | Frequency specific offset, set by<br>**GPS-*Signal Control - Signal Power*-L1 power-Global L1 Offset** | 0 dB |
| $O_S$ | Signal specific offset, set by<br>**GPS-*Signal Control - Signal Power*-L1 power-C/A code offset** | +1 dB |
| $R_0$ | $[(\text{satellite_orbital_radius})^2 - (\text{earth_radius})^2]^{1/2}$<br>$= [(26\ 560\ 632)^2 - (6\ 378\ 137)^2]^{1/2}$<br>obtain satellite_orbital_radius from **GPS-*Motion - Orbits*-Root semi major axis** (page 10-21) | 25 783 455 m |
| R | (satellite_orbital_radius) – (earth_radius)<br>= (26 560 632) – (6 378 137) | 20 182 495 m |
| $L_{TX}$ | Satellite transmit antenna loss in the direction of the receiver<br>set using ***Transmitter antenna level and phase*** patterns (page 23-20) | +2 dB |
| $L_{RX}$ | Receiver antenna loss in the direction of the GPS satellite<br>set using ***Antenna pattern*** (page 23-9) | +3 dB |


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| Parameter | Description | Value |
|---|---|---|

***Note**: A positive number in the receive and transmit antenna patterns reduces the power level*

Substituting the parameter values into the equation above gives the simulated “modelled” GPS L1 C/A signal power for the satellite with the orbit radius shown:

$P_O$ = -130 + 15 + 0 + 1 + 20*log(25 783 455 / 20 182 495) - 2 - 3

= -130 + 13.1 = -116.9 dBm

The front panel LCD of a signal generator gives the level with respect to $P_{ICD}$. In this example, the front panel LCD will show +13.1 dB.

You can make similar calculations for satellites in other constellations.

#### 10.5.1.2 Fixed

**Signal strength-Fixed** maintains the power you specify at a constant level (regardless of satellite to vehicle range and satellite antenna pattern); however, the receiver antenna pattern DOES modify the power level. In this case, SimGEN calculates output power using this equation (with the variables as in ***Modelled*** (page 10-8):

$$P_O = P_{ICD} + O_G + O_F + O_S - L_{RX} \quad \text{dBm}$$

Using the values in ***Modelled***, the simulated “fixed” GPS L1C/A signal power for that satellite is:

$P_O$ = -130 + 15 + 1 - 3

= -130 + 13.0

= -117.0 dBm

## 10.6 Satellite selection

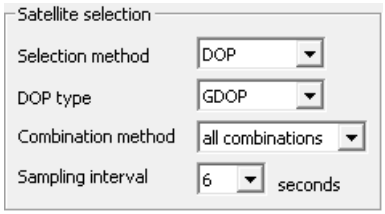
***Notes**:*

***For users of four-channel signal generators** to ensure the four simulated satellites match those the GPS receiver under test attempts to acquire, Spirent recommends you correctly set all parameters in this dialog*

***For users of eight-, or more, channel signal generators** you only need choose **DOP type**, which determines the DOP type SimGEN uses during the simulation.*

***For all users**: The BeiDou, CAPS, Galileo, GLONASS and IRNSS constellations also use this dialog*

This figure shows the **Satellite selection** dialog.




When there are more satellites visible than your signal generator can simulate, you can choose one of three **Selection method** algorithms to select the satellites your signal generator will simulate: **DOP** (Dilution of Precision, where the smaller the DOP value, the better the navigation solution), **power level** or **range**. You can also select the **Sampling interval** to set the interval between satellite selections.

When you select **Selection method-DOP**, SimGEN determines the DOP value at a particular location using the relative position of four satellites. When you choose **Selection method-DOP**, SimGEN determines the DOP value for different sets of four, visible, satellites and obtains a list of satellites ranked in order of their contribution to the better DOP sets. At the start of the scenario, SimGEN always considers all combinations (**Combination method-all combinations**) of visible satellites in selecting the sets of four satellites for DOP calculation. Subsequent updating of the simulated satellite list may use the more efficient **Combination method-sequential**, particularly if there are a large number of visible satellites.

When you select either **Selection method**-**power level** or -**range**, SimGEN selects the satellites in terms of the highest signal-level at the receiver, or closest distance to the receiver, respectively.


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| | | | |
|---|---|---|---|
| **Selection method** | choose from: | | |
| **DOP** | Gives preference to satellites giving the best DOP values.<br>This is probably the best option to optimise navigation performance for a terrestrial receiver.<br>Enables **DOP type** and **Combination method** | | |
| **power level** | Gives preference to satellites with the highest signal-levels at the receiver.<br>This might be preferred for space-borne receivers, particularly when your scenario models the satellite transmitter antenna pattern. | | |
| **range** | Gives preference to satellites nearest the receiver | | |
| **DOP type** | (Enabled with **Selection method-DOP**)<br>Choose from the list of DOP types in the drop-down list in the table below. SimGEN uses the DOP type you select in its satellite selection algorithm. It also determines the DOP value the ***Vehicle Antenna Position Details*** (page 3-4) window displays. However, your DOP type selection does not affect the DOP type in the **Sky Plot** dialog (and the DOP type you select in the **Sky plot** dialog does not affect SimGEN's algorithm). | | |
| **Combination method** | (Enabled with **Selection method-DOP**)<br>Sets the method SimGEN uses to determine the sets of four satellites that apply for the DOP calculation. Choose from: | | |
| **all combinations** | Uses all possible combinations of four satellites.<br>Always applies for the satellite selection made at the start of the scenario. | | |
| **sequential** | Uses the previous "best set" and changes one satellite at a time. This method is faster than **all combinations** and mimics the method used in some (early) types of GPS receiver.<br>The preferred method if there are a large number of visible satellites. | | |
| **Sampling interval** | The interval, during which, SimGEN revises the simulated set of satellites. In general, SimGEN simulates all visible satellites so this set will only change when a satellite rises or sets (disappears from view, with ***Earth obscuration*** (page 10-11) defining the visibility criteria).<br>Spirent recommends you use the default interval, except where the content of satellite signals is constantly changing (for example, due to your vehicle's motion in conjunction with a receiver antenna pattern that is highly directional), when Spirent recommends reducing the **Sampling interval**.<br>However, as it takes SimGEN up to one second to start a new satellite on a signal generator channel, if SimGEN includes satellites in the simulated set for very brief periods (a few seconds) there is a significant reduction in the satellite's active simulation time. | | |
| | Units: seconds | Range: 1 to 600 s | Default: 6 |

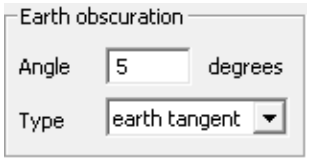
| DOP type | Description |
|---|---|
| HDOP | Best horizontal accuracy |
| PDOP | Best positional accuracy |
| VDOP | Best vertical accuracy |
| TDOP | Best time accuracy |
| GDOP | Best geometric arrangement of satellites - best general solution |

## 10.7 Earth obscuration

***Note**: The BeiDou, CAPS, Galileo, GLONASS, IRNSS, Quasi-Zenith and all SBAS constellations also use this dialog*

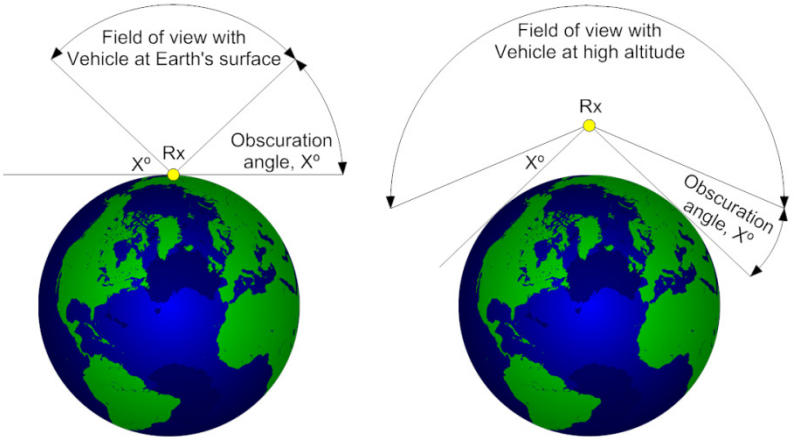
Use this dialog to determine how SimGEN calculates satellite obscuration by the Earth's surface.


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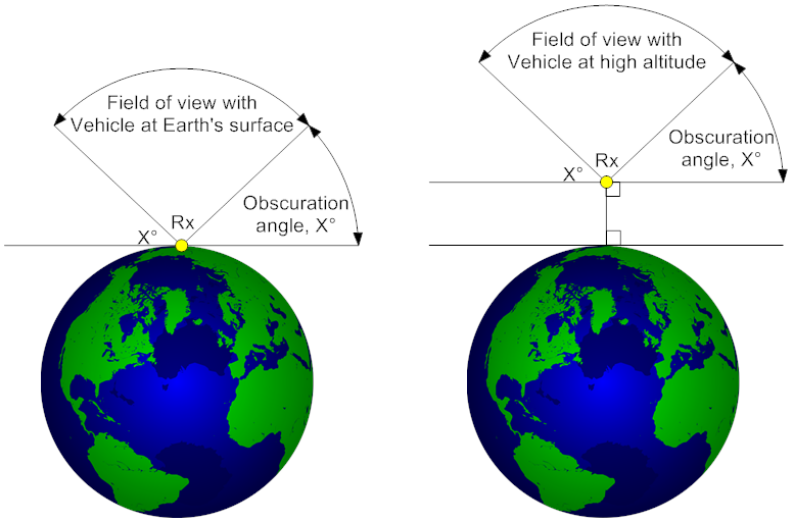



| | | | |
|---|---|---|---|
| **Angle** | The obscuration, or mask, angle above the horizon<br>The Earth masks satellites below this angle. SimGEN does not simulate satellites below this angle.<br>Many receivers let you specify an angle below which they will not attempt to track satellites. The default 5° is a common value. | | |
| | Units: degrees | Range: -5.00 to 90° | Default: 5 |
| ***Note**: When working with navigation from the Moon, you must use a negative obscuration angle to ensure simulation of satellites directly below the Moon. Spirent recommends using -2°* | | | |
| **Type** | Choose from two types of horizon | | |
| **Earth tangent** | The horizon is a line from the vehicle position tangential to the Earth's surface, see the Earth tangent horizon, below | | |
| **Local Horizontal** | The horizon is a plane perpendicular to the Earth's surface that passes through the vehicle, see the Local horizon below | | |

**Earth tangent horizon**




**Local horizon**





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## 10.8 Navigation data errors

***Notes**:*

***1)** Currently, SimGEN uses the same basic code to generate the Navigation data errors dialogs (this section) and the **Navigation data modification** (page 5-33) dialogs for all constellations using Navigation data errors or Navigation data modifications.*
*To see the Help file topic on Navigation data errors for the constellation you are using, Spirent recommend you select the Help topic you want to view from the **SimGEN Help-Contents** tab; clicking **Help** or pressing F1 on your keyboard may display an invalid Help topic.*

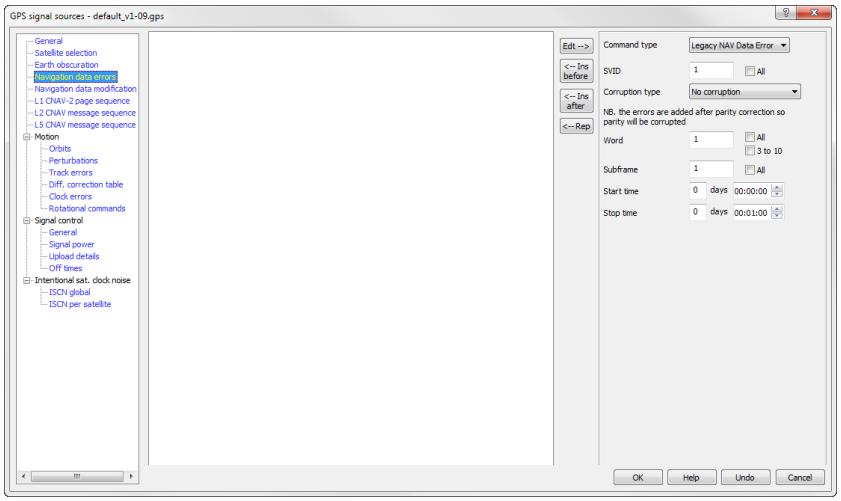
***2)** SimGEN calculates parity BEFORE making the changes, so SimGEN transmits data with incorrect parity. This tests the error detection and correction algorithms of your receiver.*

***3)** The following constellations also use this dialog, although the parameters may vary, see the links: GLONASS (page 11-7), Galileo (page 12-6), Quasi-Zenith (page 13-15), all SBAS constellations (page 14-7), LAAS (page 15-15), IRNSS (page 16-8) and BeiDou (page 18-9).*

Use the SimGEN ***List Editor*** (page 5-33) to insert errors into the GPS navigation data message. The default error is **Command Type-Legacy Nav. Data Error**.

### 10.8.1 Nav data errors - Command type - Legacy Nav Data Error

The figure below shows the dialog:




| | |
|---|---|
| **SVID** | Type the SVID you want to use or select **All** |
| **Corruption type** | Choose from: |
| **No corruption** | |
| **Set one bit** | Inverts bit 1 of **Word** after calculating parity |
| **Set two bits** | Inverts bit 1 and 4 of **Word** after calculating parity |
| **Set three bits** | Inverts bits 1,4 and 6 of **Word** after calculating parity |
| **Set all zero** | Sets all bits of **Word** to zero, including parity bits |
| **Set word alternate 0 and 1** | Including parity bits |
| **Diverge IODC and IODE** | Adds seven to the original value of IODC |
| ***Note**: Reference a) defines the bit numbering for the 30-bit words. The first bit transmitted is bit 1 of the word. SimGEN transmits Parity at the end of the word in bits 25 to 30.* | |
| **Word** | Type the word you want to modify or select **All** or **3 to 10** |
| **Subframe** | Type the subframe you want to modify or select **All** |


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| | | | |
|---|---|---|---|
| **Start time**<br>**Stop time** | Units:<br>d hh:mm:ss | Range:<br>0 days 00:00:00<br>to 23 days 23:59:59 | **Start** default:<br>0 days 00:00:00 (start of run)<br>**Stop** default:<br>0 days 00:01:00 |

### 10.8.2 Nav data errors - Command type - L1C Nav Data Error

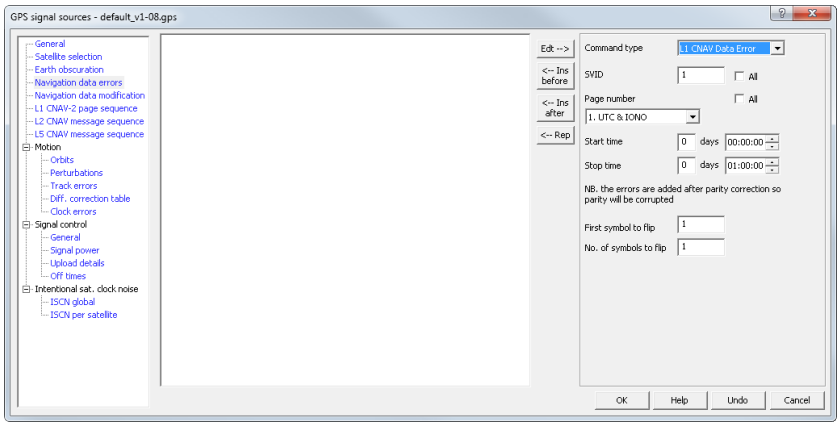
***Note**: Currently, SimGEN only applies GPS L1C navigation data errors to GSS9000-series, GSS8000-series, GSS7000 and GSS7700 signal generators.*

The L1C Navigation message differs from the Legacy GPS Navigation message. Reference u) gives a full explanation of the CNAV-2 content and structure.

This table gives some important points on the L1C (CNAV-2) Navigation message.

| CNAV-2 parameter | Description |
|---|---|
| Data rate | 100 symbols per second (approximately 50 bps) |
| Message length | 883 bits (1 800 symbols) |
| Message content | 3 subframes:<br>Subframe 1: 9 bits (52 symbols)<br>Subframe 2: 600 bits (1200 symbols)<br>Subframe 3: 274 bits (548 symbols) - this subframe is commutated over multiple pages |
| Message encoding | Subframe 1: BCH<br>Subframe 2: LDPC<br>Subframe 3: LDPC |

The figure below shows the dialog:




| | | | |
|---|---|---|---|
| **SVID** | Type the SVID you want to use or select All | | |
| **Page number** | Select the Page number you want to use from the drop-down or select All | | |
| ***Note**: The page type of subframe 3 references the full L1C message of 1 800 symbols* | | | |
| **Start time**<br>**Stop time** | Units:<br>d hh:mm:ss | Range:<br>0 days 00:00:00<br>to 23 days 23:59:59 | **Start** default:<br>0 days 00:00:00 (start of run)<br>**Stop** default:<br>0 days 00:01:00 |
| **First symbol to flip** | Type the first symbol of the message to invert (flip) Range: 1 to 1 800 | | |
| **No. of symbols to flip** | Type the number of symbols in the message to invert (flip) | | |
| ***Note**: SimGEN adds these errors after parity correction, so parity is corrupted* | | | |


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### 10.8.3 Nav data errors - Command type - L2C Nav Data Error

***Note**: From SimGEN version 5.03 onwards, Spirent includes **Message type-63**, which is a temporary, user-defined, message type that defaults to the NULL message content (that is 1's and 0's) with the first 38 bits set to include preamble, prn, message id (63 by default) and TOW, as in other messages.*

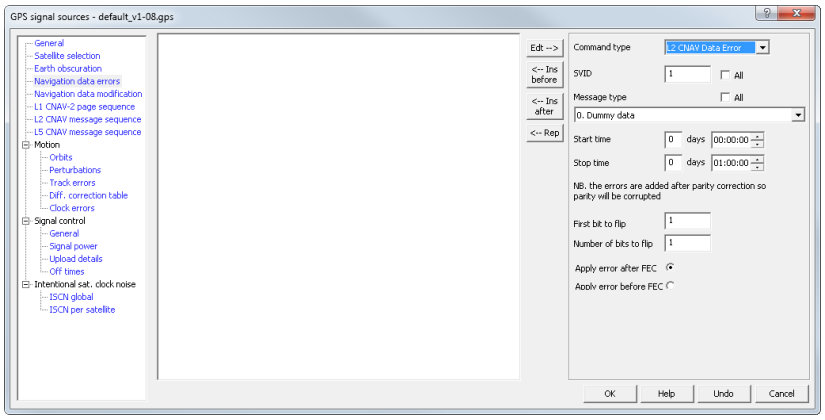
*Currently, the GPS ICD references bb) and cc) do not include this message. Spirent includes this message to provide flexibility for SimGEN users until the ICD's fully populate the message array (0 to 63); at this point, Spirent reserves the right to revert to the ICD and consider an alternative form for this user-defined message.*

The L2C Navigation message (CNAV) differs from the original GPS Navigation message. Reference a) gives a full explanation of CNAV content and structure.

This table gives some important points on the L2C Navigation message.

| CNAV parameter | Description |
|---|---|
| Data rate | 25 bps |
| Message types | Six, you can sequence, repeat and prioritise them as in SBAS |
| Message length | 300 bits long - 276 data bits and 24 CRC bits |
| Message encoding | ½ rate FEC - produces a 600 symbol stream |

This figure shows the dialog:

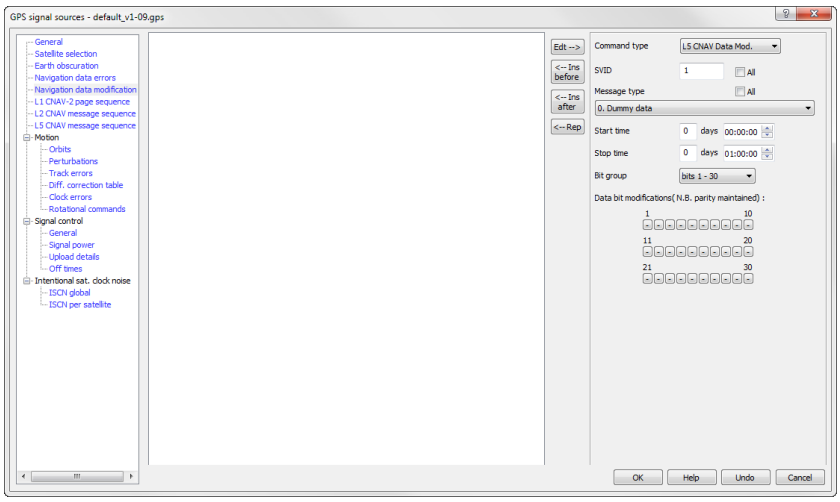



| | | | |
|---|---|---|---|
| **SVID** | Type the SVID you want to use or select **All** | | |
| **Message type** | Select the Message type you want to use from the drop-down menu or select **All** | | |
| **Start time**<br>**Stop time** | Units:<br>d hh:mm:ss | Range:<br>0 days 00:00:00<br>to 23 days 23:59:59 | **Start** default:<br>0 days 00:00:00 (start of run)<br>**Stop** default:<br>0 days 00:01:00 |
| **First bit to flip** | This depends when you apply the error:<br>Error after FEC: Type the first symbol of the 600 broadcast symbols to invert (flip)<br>Error before FEC: Type the first bit of the 300-bit message to invert (flip) | | |
| **Number of bits to flip** | Type the number of bits (or symbols) in the message to invert (flip) | | |
| ***Note**: Before this corruption, SimGEN calculates and appends the 24 CRC bits to the data* | | | |
| **Apply error after FEC** | (default) Select to apply the error after SimGEN generates the symbol stream | | |
| **Apply error before FEC** | Select to apply the error before SimGEN generates the symbol stream - the CRC is invalid | | |

### 10.8.4 Nav data errors - Command type - L5 Nav Data Errors

The **L5 Nav Data Error** dialog is the same as the **L2C Nav Data Error** dialog:


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L5 and L2C have very similar Navigation Data structures - except for the number of supported message types.

See reference a) for full details on the content and structure of the GPS L5 Navigation Data message.

## 10.9 Navigation data modification

***Notes**:*

***1)** The following constellations also use this dialog, although the parameters may vary, see the links: GLONASS (page 11-8), Galileo (page 12-7), Quasi-Zenith (page 13-17), all SBAS constellations (page 14-7), LAAS (page 15-15), IRNSS (page 16-11) and BeiDou (page 18-10).*

***2)** Currently, SimGEN uses the same basic code to generate the **Navigation data errors** (page 5-33) dialogs and the Navigation data modifications dialogs (this section) for all constellations using Navigation data errors or Navigation data modifications.*
*To see the Help file topic on Navigation data modification for the constellation you are using, Spirent recommend you select the Help topic you want to view from the **SimGEN Help-Contents** tab; clicking **Help** or pressing F1 on your keyboard may display an invalid Help topic.*

This dialog supports legacy navigation data, L1 CNAV-2, L2 CNAV and L5 can. You can modify the navigation data messages using the SimGEN ***List Editor*** (page 5-33) and save the User actions to a User actions file (**.act*). SimGEN calculates parity bits **AFTER** modifying the data, so the modified message has correct parity. This dialog lets you modify specific data fields in the navigation data message so you can check your receiver decodes them correctly.

Reference a) gives positioning and bit numbering for these navigation data message fields.

This table shows the options for modifying each data bit (excluding parity or CRC bits) in each dialog. Click on each data bit button to cycle through the options.

| Symbol | Description |
|---|---|
| **-** | Leave bit as is |
| **0** | Set bit to 0 |
| **1** | Set bit to 1 |
| **X** | Invert bit (from that originally calculated) |

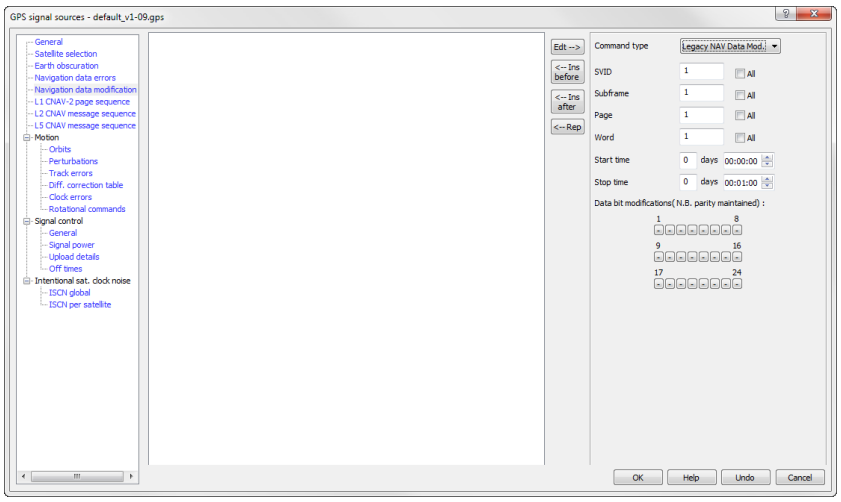
### 10.9.1 Nav data mods - Command type - Legacy Nav Data Mod

***Note**: Regardless of your choice of **Subframe**, you must also specify the **Page** to which the navigation data modifications apply.*

*The ability to modify a single page offers greater control, although **Subframe 1** to **Subframe 3** contains the same data on all pages.*
*If you do not require this control, select **Page-All**.*

This figure shows the dialog:


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| | | | |
|---|---|---|---|
| **SVID** | Type the SVID you want to use or select **All** | | |
| **Subframe** | Type the subframe you want to modify or select **All** | | |
| **Page** | See the ***Note*** above and type the page you want to modify. | | |
| **Word** | Type the word you want to modify or select **All** | | |
| **Start time**<br>**Stop time** | Units:<br>d hh:mm:ss | Range:<br>0 days 00:00:00<br>to 23 days 23:59:59 | **Start** default:<br>0 days 00:00:00 (start of run)<br>**Stop** default:<br>0 days 00:01:00 |
| **Data bit modification** | Navigation Data words have 30 bits<br>Modify non-parity bits 1 to 24 using these buttons. This table (page 10-16) details the symbols on each button.<br>Bits 25 to 30 are parity bits.<br>The default is “leave bit as is” | | |

This table shows the number of pages for each available subframe.

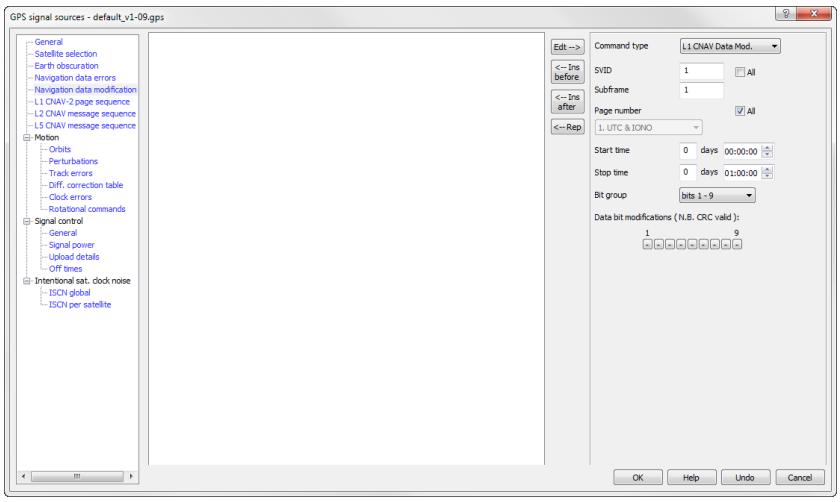
| Subframe | Number of pages | Reminder in System messages window |
|---|---|---|
| 1 to 3 | 25 pages per subframe | ✓ |
| 4 to 5 | 1 page per subframe | ✗ |

After selecting **Command type-Legacy NAV Data Mod**, depending on the **Subframe** you select SimGEN displays a message in the **System Messages** window to remind you this **Command type** applies only to a specific **Page** in a **Subframe** (see the table above). If you want this **Command type** to apply to all pages, select **Page-All**. If you use the SimREMOTE version of this command - see reference qq), the same reminder also appears in the string send response area.

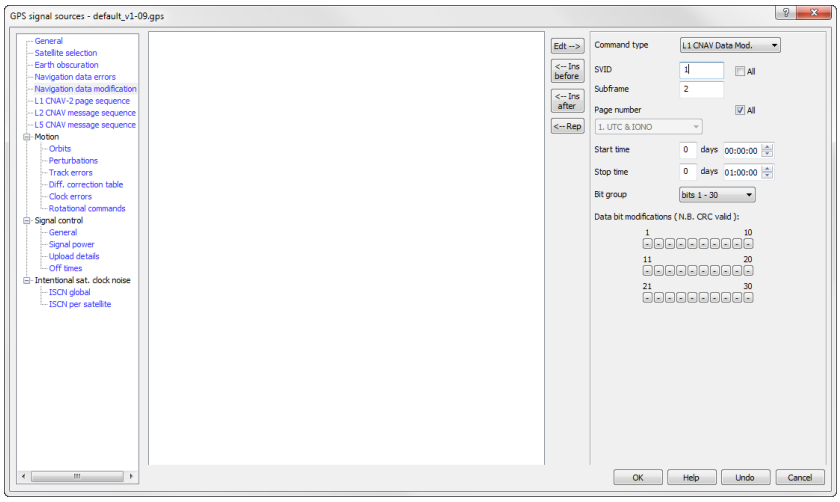
## 10.9.2 Nav data mods - Command type - L1C Nav Data Mod

The three figures below show entries for **Subframe -1**, **Subframe -2** and **Subframe -3**. **Subframe -1** and **Subframe -2** show **Page number** as disabled and **All** selected, notice the available **Bit groups** are different.

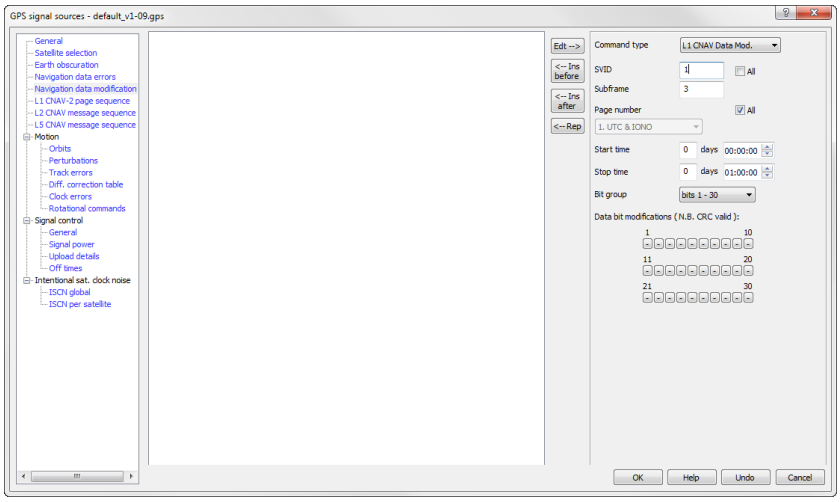
**Subframe-1**




**Subframe-2**




**Subframe-3** deselect **All** to use the dropdown menu to select a specific **Page number**:




| | |
|---|---|
| **SVID** | Type the SVID you want to use or select **All** |
| **Subframe** | Type the subframe you want to modify (**1**, **2** or **3**) or select **All** |
| **Page number** | Page number for **Subframe-1** and -**2** is disabled and SimGEN sets **All** by default<br>In **Subframe-3**, deselecting **All** enables **Page number**. Choose the Page number you want to modify from the drop down menu. |


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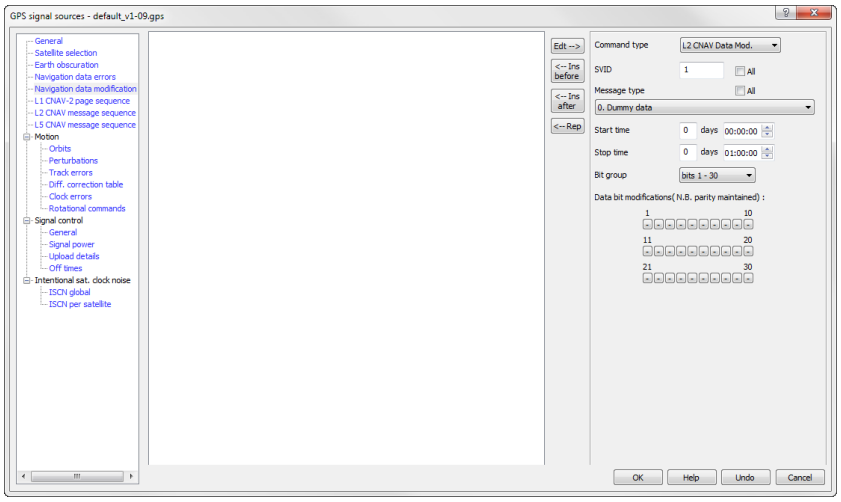
| | | | |
|---|---|---|---|
| **Start time**<br>**Stop time** | Units:<br>d hh:mm:ss | Range:<br>0 days 00:00:00<br>to 23 days 23:59:59 | **Start** default:<br>0 days 00:00:00 (start of run)<br>**Stop** default:<br>0 days 00:01:00 |
| **Bit group** | Varies depending on the **Subframe** entry.<br>**Subframe-1** choose from bits 1 to 9,<br>**Subframe-2** choose a block of 30 bits from bits 1 to 576,<br>**Subframe-3** choose a block of 30 bits from bits 1 to 250 | | |
| **Data bit modification** | Modify the block of bits using these buttons. This table (page 10-16) details the symbols on each button.<br>Bits 25 to 30 are parity bits.<br>The default is “leave bit as is” | | |

### 10.9.3 Nav data mods - Command type - L2C Nav Data Mod

***Note**: From SimGEN version 5.03 onwards, Spirent includes **Message type-63**, which is a temporary, user-defined, message type that defaults to the NULL message content (that is 1's and 0's) with the first 38 bits set to include preamble, prn, message id (63 by default) and TOW, as in other messages.*

*Currently, the GPS ICD references bb) and cc) do not include this message. Spirent includes this message to provide flexibility for SimGEN users until the ICD’s fully populate the message array (0 to 63); at this point, Spirent reserves the right to revert to the ICD and consider an alternative form for this user-defined message.*

The L2C message structure consists of 276 data bits and 24 CRC bits.




| | | | |
|---|---|---|---|
| **SVID** | Type the SVID you want to use or select **All** | | |
| **Message type** | Select the message type you want to modify or select **All** | | |
| **Start time**<br>**Stop time** | Units:<br>d hh:mm:ss | Range:<br>0 days 00:00:00<br>to 23 days 23:59:59 | Start default:<br>0 days 00:00:00 (start of run)<br>Stop default:<br>0 days 00:01:00 |
| **Bit group** | Select the bit group you want to modify | | |
| **Data bit modification** | The L2C message has 276 data bits and 24 CRC bits<br>Modify any of the 276 data bits by first selecting the **Bit group** and then making the **Data bit modification** using the buttons.<br>This table (page 10-16) details the symbols on each button.<br>The default is “leave bit as is”. | | |

### 10.9.4 Nav data mods - Command type - L5 CNAV Data Mod

Navigation Data modifications for L5C are identical to L2C see the previous section.


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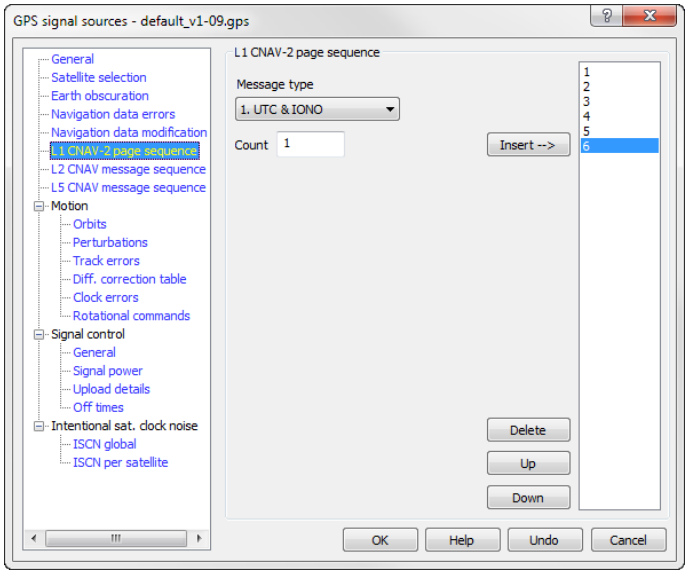
# 10.10 Message sequence

***L1 CNAV-2 page sequence*** to ***L2 CNAV and L5 CNAV message sequence*** describe setting the CNAV page or message sequences.

## 10.10.1 L1 CNAV-2 page sequence

***Note**: This dialog modifies Subframe 3 Message types*

The following figure shows this dialog:




The right-hand area displays the sequence of Subframe 3 Message types SimGEN will apply in the run. To apply a new message:

- In the right-hand area, highlight the message that will precede the new message
- Select the Subframe 3 **Message type** you want to use
- Click **Insert**.
- You can enter more than one of the selected messages by typing the number of messages in **Count**.

After you insert a message, you can change its position compared with other messages by selecting the message in the right-hand area and clicking **Up** and **Down**.

You can delete a message by selecting it and clicking **Delete**. During a simulation when the message sequence ends, the sequence cycles back to the first message and repeats.

## 10.10.2 L2 CNAV and L5 CNAV message sequence

***Notes***

**1)** *The L5 CNAV message sequence is identical to the L2 CNAV message sequence.*

**2)** *Message types 1 to 6 refer to revision B.*

***3)** Message types 10 to 15 and 30 to 36 refer to revision D.*

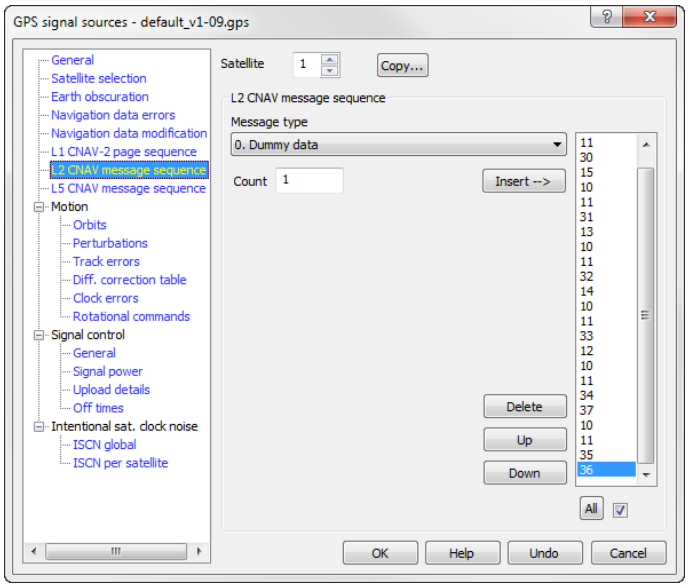
***4)** From SimGEN version 5.03 onwards, Spirent includes **Message type-63**,in L2 CNAV. This is a temporary, user-defined, message type that defaults to the NULL message content (that is 1's and 0's) with the first 38 bits set to include preamble, prn, message id (63 by default) and TOW, as in other messages.*

*Currently, the GPS ICD references bb) and cc) do not include this message in L2 CNAV. Spirent includes this message to provide flexibility for SimGEN users until the ICD's fully populate the message array (0 to 63); at this point, Spirent reserves the right to revert to the ICD and consider an alternative form for this user-defined message.*

***5)** Currently, SimGEN uses the same basic code to generate navigation data message sequence dialogs for all constellations.*
*To see the Help file topic on navigation data message sequence for the constellation you are using, Spirent recommend you select the Help topic you want to view from the **SimGEN Help-Contents** tab; clicking **Help** or pressing F1 on your keyboard may display an invalid Help topic.*


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Use this dialog to select the message types for transmission and define the sequencing.




| | |
|---|---|
| **Satellite** | Select the Satellite whose settings you want to change.<br>Click **Copy…** to copy these parameters to the Satellites you select in the dialog. |
| **Message type** | Select the **Message type** you want to use, then click **Insert-->**.<br>You can enter more than one of the selected messages by typing the number of messages in **Count**. |
| **Up** and **Down** | After you insert a message, change its position compared with other messages by selecting the message in the right-hand area and clicking **Up** and **Down**. |
| **Delete** | Delete a message by selecting it and clicking **Delete** |

During a simulation, when the message sequence ends, the sequence cycles back to the first message and repeats.

## 10.11 Motion

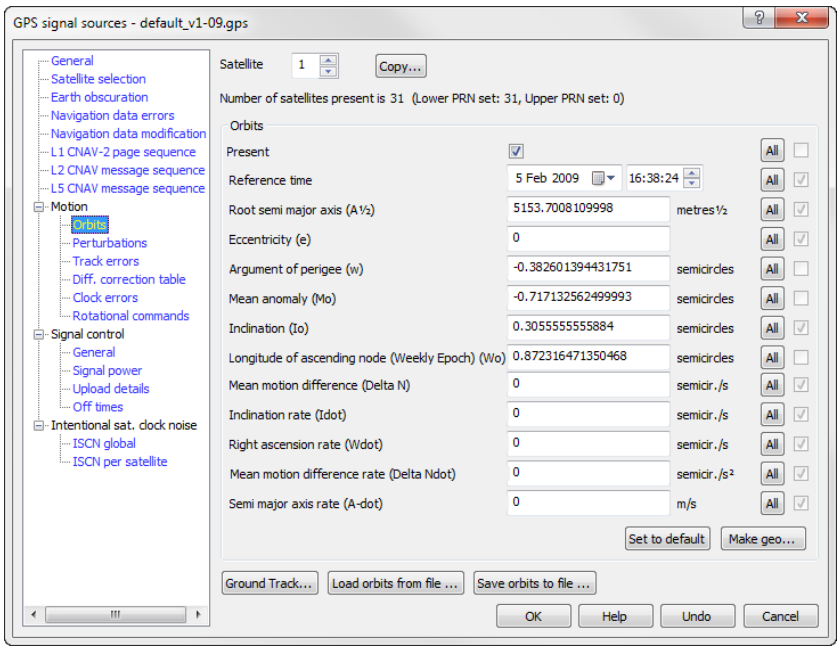
These dialogs change the satellite orbits.

### 10.11.1 Motion - Orbits

***Note**: Currently, SimGEN uses the same basic code to generate Motion dialogs for all constellations.*
*To see the Help file topic on Motion for the constellation you are using, Spirent recommend you select the Help topic you want to view from the **SimGEN Help-Contents** tab; clicking **Help** or pressing F1 on your keyboard may display an invalid Help topic.*

Use this dialog to define the satellite orbits. The default data describes the “standard” GPS constellation of 24 satellites, comprising four satellites in each of six orbital planes - see reference b).

In the dialog. **Lower PRN set** refers to the number of satellites for constellations defined in ICDs before ICD-GPS-200F (legacy constellation). **Upper PRN set** refers to the number of satellites in the extended constellation defined in ICD-GPS-200F onwards. **Upper PRN set** is always zero when **GPS signal sources-*General*-Extended constellation** is not selected.




If you want to use a constellation with less than 32 satellites, select the **Satellite** you do not need and deselect **Present**.

The dialog shows the parameters for the satellite identified by the **Satellite**. As you scroll through the satellites, the orbital parameters alter accordingly. Click **All** to set any parameter to be the same for all satellites.

Reference a) defines all the terms in the dialog.

| | | | |
|---|---|---|---|
| **Satellite** | Select the Satellite whose settings you want to change.<br>Click **Copy…** to copy these parameters to the Satellites you select in the dialog.<br><br>Number of satellites present is 24 (Lower PRN set: 24, Upper PRN set: 0) refers to the total number of satellites in your scenario and compatibility with reference b). | | |
| **Present** | Select (default): includes **Satellite** in scenario.<br>Deselect: treats **Satellite** as non-existent and does not include **Satellite** in the Navigation data almanac set. | | |
| **Reference time** | Reference date and time at which orbit details are valid. This time is analogous to t*oe* in the satellite data message. You can use ephemeris data from real satellites to describe the simulated orbits if the reference time is set to the t*oe* of the ephemeris data. | | |
| | Units:<br>d hh:mm:ss.ss | Range:<br>06 January 1980 00:00:00.00<br>to<br>06 January 2048 23:59:59.00 | |
| ***Note**: If the orbit terms such as **inclination Rate** or **Right ascension rate** are non-zero, you must consider the difference between **Reference time** and the scenario start time. A large time difference can cause the orbits to diverge significantly, giving unexpected results. Normally, **Reference time** should be close to the scenario start time* | | | |
| **Root semi major axis** (A½) | Units metres$^{½}$ | Range: 2 537.0 to 6 557.0 m$^{½}$ | Default:<br>5 153.700 810 999 8<br>(gives orbit period in reference a) |
| **Eccentricity (e)** | Units: none | Range: 0 to 0.2 | Default: 0 |
| **Argument of perigee (w)** | Units: semi-circles | Range: -1 to +1 semi-circle | Default: 0 |
| **Mean anomaly (Mo)** | Units: semi-circles | Range: -1 to +1 semicircle | Default: for first 21 Satellites in reference a) |


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| | | | |
|---|---|---|---|
| **Inclination (Io)** | Units: semi-circles | Range: -1<br>to +1 semi-circle | Default:<br>0.305 555 555 588 4 |
| ***Note**: Inclination outside the range 0.237 5 to 0.362 498 semi-circles will exceed the range of almanac δi. The simulation will limit δi to the maximum or minimum value as appropriate with the result the almanac data will be inaccurate.* | | | |
| **Longitude of ascending node (Weekly Epoch) (Wo)** | Units: semicircles | Range: -1<br>to +1 semicircle | Default: for first 21 Satellites in reference a) |
| ***Note**: The reference time for **Wo** is the weekly epoch at or before the orbit reference time.* | | | |
| **Mean motion difference (Delta N)** | Units: semi-circles per second | Range: -3.725 29 E-9<br>to +3.725 177 E-9 semicircles.$s^{-1}$ | Default: 0 |
| **Inclination rate (Idot)** | Units: semi-circles per second | Range: -0.931322 78 E-9 to +0.931 208 89 E-9 semicircles.$s^{-1}$ | Default: 0 |
| ***Note**: When there is a large difference between **Reference Time** and the start of the scenario, use **Inclination rate** with caution. Extrapolation of the ephemeris over a long period could cause a significant change in inclination angle and may exceed the range of almanac δi (see **Inclination**).* | | | |
| **Right ascension rate (Wdot)** | Units: semi-circles per second | Range: -0.953 674 28 E-6 to +0.953 674 2 E-6 semicircles.$s^{-1}$ | Default: 0 |
| ***Note**: When there is a large difference between **Reference Time** and the start of the scenario use **Right ascension rate** with caution. Extrapolation of the ephemeris over a long period could cause a significant change in **Longitude of ascending node*** | | | |
| **Mean motion difference rate (Delta Ndot)** | Units: semi-circles per $(second)^2$ | Range: -3.725 29 E-9<br>to +3.725 177 E-9 semicircles.$s^{-2}$ | Default: 0 |
| **Root semi major axis rate** (A-dot) | Units: metres per second | Range: -8.0<br>to 7.999 999 952 m.$s^{-1}$ | Default: 0 |

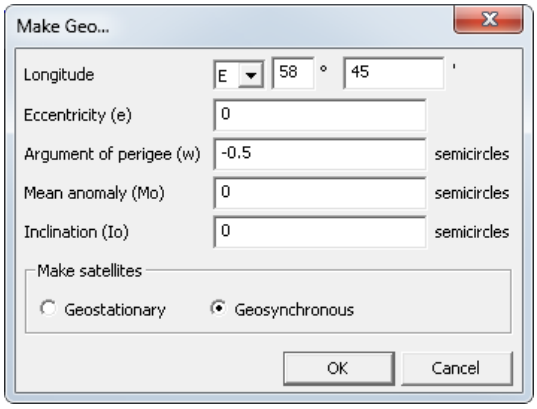
#### 10.11.1.1 Set to default

This button sets each parameter to its default value.

#### 10.11.1.2 Make geo

***Note**: You can create constant pseudorange signals for specific receiver tests by creating a scenario with a static vehicle and one or more geostationary satellites*

Use this dialog to set **Satellite** as geostationary or geosynchronous:



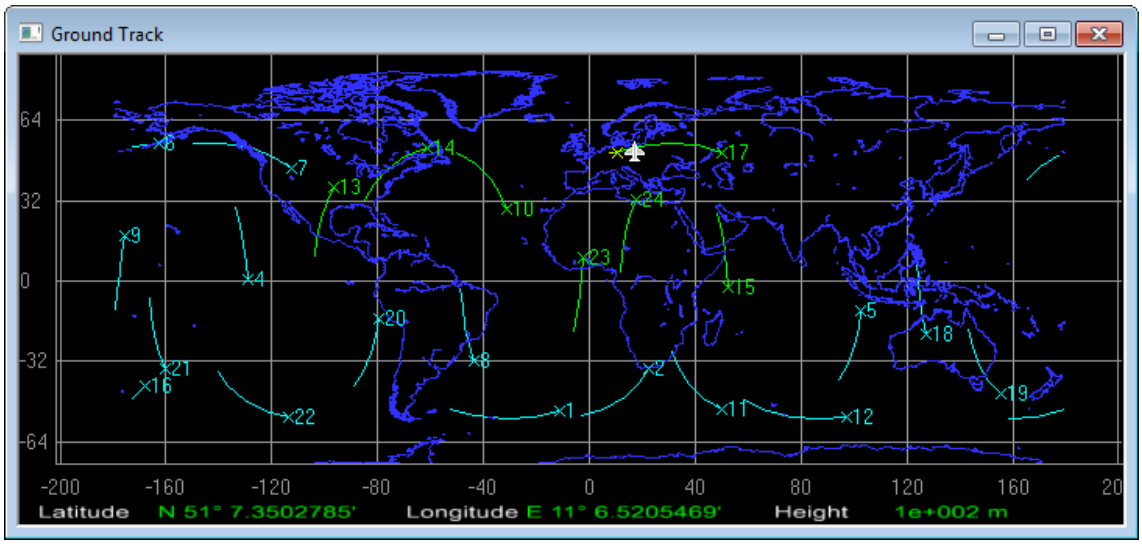


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| | | | |
|---|---|---|---|
| **Make satellites** | Geostationary (default): sets **Satellite** to geostationary (automatically setting eccentricity to zero and orbit radius to the correct geostationary orbit height).<br><br>Geosynchronous:sets **Satellite** as geosynchronous and enables **Eccentricity (e)**, **Argument of perigee (w)**, **Mean anomaly (Mo)** and **Inclination (Io)** (see the figure below this table).<br>After setting these parameters and clicking **OK**, SimGEN adjusts the remaining orbital parameters to give the geosynchronous orbit and sets reference time to the start of the current week. | | |
| **Longitude** | **Geostationary**: enter the longitude of the satellite.<br>**Geosynchronous**: enter the mean longitude (the crossing point of the resulting "figure-of-eight" orbit). | | |
| | Units: degrees and decimal minutes | Range: 0 to 180° (**E**ast or **W**est) | Default: satellite dependent |
| ***Note**: The latitude of any geostationary satellite is always zero. By definition, you must position a geostationary satellite over the equator using longitude only. Inclined geosynchronous satellites will have varying latitudes* | | | |
| **Eccentricity (e)** | The "shape" of the elliptical orbit. When e = 0 the ellipse is a circle | | |
| | Units: none | Range: 0 to 0.2 | Default: 0 |
| **Argument of perigee (w)** | Angle between the orbit perigee and the ascending node | | |
| | Units: semicircles | Range: ±1 semicircles | Default: -0.5 |
| **Mean anomaly (Mo)** | Orbital position of satellite at the orbit reference time | | |
| | Units: semicircles | Range: ±1 semicircles | Default: 0 |
| ***Note**: Adjustment of **Mean Anomaly (Mo)** lets you move the satellite around the orbit, which is useful if you want to assign the same nominal longitude to a number of satellites* | | | |
| **Inclination (Io)** | The angle between the orbital plane and the equatorial plane | | |
| | Units: semicircles | Range: ±1 semicircles | Default: 0 |

### 10.11.1.3 Ground Track...

Shows the spatial positioning and trajectory of each satellite, with reference to the currently defined scenario for each satellite, for example:





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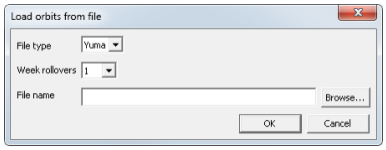
### 10.11.1.4 Load orbits from file

***Note**:*

***1)** Spirent recommends you set to zero data for any parameter not updated.*

***2)** The BeiDou, CAPS, Galileo, IRNSS and Quasi-Zenith constellations also link to this dialog.*

Orbital data for satellites is available for download in different formats. SimGEN lets you load orbital data in Yuma, TLE, Rinex and SEM formats using this dialog:




| | |
|---|---|
| **File type** | The two tables below give the effects of using various orbital files.<br>Select from: |
| **Yuma** | (default)<br>SimGEN sets all satellites defined in the Yuma file as **Present**.<br>To download current (real-world) almanac data, open www.navcen.uscg.gov in a web browser and navigate to the almanac download page.<br>SimGEN uses an ASCII format text file and recognises all extensions on the downloads available from this website. |
| **TLE** | The TLE format identifies individual satellites using their NORAD satellite catalogue number (SATCAT, which does not use the PRN). You can download the SATCAT master catalogue here: http://www.celestrak.com/pub/satcat.txt.<br>Spirent includes the file *…/Datum Files/TLE_GNSS_SATNO.txt*, which maps the SATCAT identifier to GNSS satellite PRN/SVID. If you use TLE files, this file allows SimGEN to associate each satellite with the appropriate TLE data. Spirent recommends you regularly download the latest version of this file (and save it as *TLE_GNSS_SATNO.txt* in the *Datum Files* folder), from this location:<br>https://raw.githubusercontent.com/tomojitakasu/RTKLIB/master/data/TLE_GNSS_SATNO.txt<br><br>You can download from NORAD the latest TLE format files for these constellations:<br>Index: http://www.celestrak.com/NORAD/elements/<br>BeiDou: http://www.celestrak.com/NORAD/elements/beidou.txt<br>Galileo: http://www.celestrak.com/NORAD/elements/galileo.txt<br>GLONASS: http://www.celestrak.com/NORAD/elements/glo-ops.txt<br>GPS: http://www.celestrak.com/NORAD/elements/gps-ops.txt<br>Quasi-Zenith: http://www.celestrak.com/NORAD/elements/sbas.txt<br><br>Currently, you can download IRNSS TLE format files from this site:<br>http://www.n2yo.com/database/?q=IRNSS<br><br>Notice SimGEN uses the **.tle* extension for TLE files and you must change the extension of any files you download to **.tle*. |
| **Rinex** | Disables **Week Rollovers**<br>This is a text file with the standard Rinex extension **yyn*.<br><br>References ii) (Rinex version 2.10) and jj) (Rinex version 3.0) specify the Rinex formats that SimGEN currently supports.<br>Spirent recommends you ensure the Rinex format files you use comply exactly with the requirements in the Rinex specifications |


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| | | | |
|---|---|---|---|
| ***Note**: If you load a Rinex file with more than one dataset for a satellite, SimGEN loads the most recent dataset (this is the dataset closest to the bottom of the file) and ignores all preceding datasets.*<br><br>***Note when reading from Rinex files:** You must select **Scenario-Start time-UTC offset control-legacy(constellation file)** (page 4-15) before SimGEN can read leap seconds from Rinex files. If you do not select **legacy(constellation file)**, SimGEN will use the value you entered in <**scenario name**>**-Start time-fixed** (page 4-15) or the value in history.txt if you selected **Scenario-Start time-automatic*** | | |
| **SEM** | Similar to Yuma format.<br><br>To download current (real-world) almanac data, open www.navcen.uscg.gov in a web browser and navigate to the almanac download page.<br>SimGEN uses an ASCII format text file and recognises all extensions on the downloads available from this website. | | |
| **Week rollovers** | Available for **File types-Yuma** and **-SEM**<br>The GPS service started on 6th January 1980. The GPS week number rolls over to zero after a period of 1 024 weeks, with the first rollover occurring on 22nd August 1999. However, there is an ambiguity as most Yuma almanac files use modulo 1 024 for week numbers. Consequently, an almanac set for week number 1 might be for 1980 or 1999.<br>Selecting the appropriate **Week rollover** defines the period for the almanac data. Week rollover-1 defines the 1024-week period starting 22nd August 1999. | | |
| | Units: n/a | Range: 0 to 5 | Default: 1 |
| **Filename** | Click **Browse...** and navigate to the location of the orbital file to use | | |

The first table shows, for each of the Yuma, TLE, Rinex and SEM formats, the satellite dependent parameters that are updated on an upload. The second table shows the same details for satellite independent parameters.

| Satellite independent parameter | Parameter updated for format | | | |
|---|---|---|---|---|
| | **Yuma** | **TLE** | **Rinex** | **SEM** |
| **Reference Time** | ✓ | ✓ | ✓ | ✓ |
| **Root Semi-Major Axis (A½)** | ✓ | ✓ | ✓ | ✓ |
| **Eccentricity (e)** | ✓ | ✓ | ✓ | ✓ |
| **Argument of Perigee (w)** | ✓ | ✓ | ✓ | ✓ |
| **Mean Anomaly (Mo)** | ✓ | ✓ | ✓ | ✓ |
| **Inclination (Io)** | ✓ | ✓ | ✓ | ✓ |
| **Longitude of Ascending Node (Wo)** | ✓ | ✓ | ✓ | ✓ |
| **Right Ascension Rate (Wdot)** | ✓ | ✘ | ✓ | ✓ |
| **Clock Correction Terms (Af0 and Af1)** | ✓ | ✘ | ✓ | ✓ |
| **Nav Data Health (Upload 1 and 2)** | ✓ | ✘ | ✘ | ✓ |
| **Mean Motion Difference (Delta N)** | ✘ | ✘ | ✓ | ✘ |
| **Inclination Rate (Idot)** | ✘ | ✘ | ✓ | ✘ |
| **Clock Correction Term Af2** | ✘ | ✘ | ✓ | ✘ |
| **Perturbation errors (Cuc, Cus, Cic, Cis, Crc, Crs)** | ✘ | ✘ | ✓ | ✘ |


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| Satellite independent parameter | Parameter updated for format | | | |
|---|---|---|---|---|
| **Track Errors (Along, Across, Down)** | ✘ | ✘ | ✘ | ✘ |
| **Group delay (Tgd)** | ✘ | ✘ | ✓ | ✘ |
| **Satellite signal health** | ✘ | ✘ | ✓ | ✓ |
| **Anti-spoof flag (GPS only)** | ✘ | ✘ | ✘ | ✓ |
| **SV config code (GPS only)** | ✘ | ✘ | ✘ | ✓ |

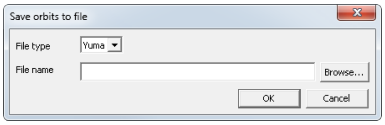
***Note**: Currently, Spirent does not update Ionospheric coefficients*

| Satellite independent parameter | Parameter updated for format | | | |
|---|---|---|---|---|
| | **Yuma** | **TLE** | **Rinex** | **SEM** |
| **GPS to UTC time difference** | ✘ | ✘ | ✓ | ✘ |
| **Ionospheric model coefficients Alpha 0 to 3 and Beta 0 to 3** | ✘ | ✘ | ✘ | ✘ |

### 10.11.1.5 Save orbits to file

***Note**: The BeiDou, CAPS, Galileo, IRNSS and Quasi-Zenith constellations also link to this dialog.*

Save the current satellite orbital data in Yuma, TLE, Rinex or SEM formats using this dialog:




| **File type** | Select from: |
|---|---|
| **Yuma** | (default)<br>This is an ASCII text file. Spirent recommends you save this file using the extensions **.txt* or **.alm* |
| **TLE** | This is an ASCII text file using the extension **.tle*.<br>***Load orbits from file*** (page 10-25) gives more details on the TLE file format |
| **Rinex** | Enables **Version**<br>Rinex files are text files that you must save with the standard Rinex extension **.yyn*.<br><br>References ii) (Rinex version 2.10) and jj) (Rinex version 3.0) specify the Rinex formats that SimGEN currently supports<br>SimGEN outputs Rinex format files that comply with the requirements in the Rinex specifications |
| ***Note when writing to Rinex files:** The value SimGEN uses for Leap seconds depends on your selection in **Scenario-Start time-UTC offset control** (page 4-15), as follows:*<br>***-fixed**: SimGEN writes the value from your entry for **UTC offset** to the Rinex file*<br>***-automatic**: SimGEN writes the value from the history.txt file it uses*<br>***-Legacy (constellation file)**: SimGEN writes the value you specify in **General-GPS time leads UTS by** (page 10-6) (or in the Galileo constellation, **System time-GST leads UTC by** (page 12-3))* | |

| | |
|---|---|
| **SEM** | This is an ASCII text file. Spirent recommends you save this file using the extensions **.txt* or **.al3*<br>***Notes**:*<br>***1)** Currently, SimGEN supports saving orbits to SEM format only for GPS and IRNSS satellites*<br>***2)** The Time of Applicability is the first 4096 epoch after the Scenario start time* |
| **Version** | Enabled only when you select **Rinex**<br>**2.10** (default): ***Example GPS Rinex file - version 2.10 format*** lists an example file using this version and a description of the file contents<br>**3.00**: ***Example GPS Rinex file - version 3.00 format*** (page 10-31) lists an example file using this version and a description of the file contents |
| **Filename** | Click **Browse...** and navigate to the location where you want to save the new orbital file |

### 10.11.1.5.1 Example GPS Rinex file - version 2.10 format

***Notes**:*

***1)** Currently, SimGEN can export data for GPS and GLONASS satellites as Rinex version 2.10 format file - see reference ii)*
*For an example of a GLONASS Rinex file in version 2.10 format, see **Example GLONASS Rinex file - version 2.10 format** (page 11-19)*

***2)** Currently, SimGEN exports Rinex files using "D" to represent the decimal exponent. Reference ii) allows the decimal exponent to be one of "d", "D", "e" or "E"*

This example file listing shows the format of the GPS Rinex version 2.10 file (the colour of the text is inverted every fifth line for readability):

```
   2.10           N: NAV DATA GPS             RINEX VERSION / TYPE
SimGEN V5.03.00    Spirent       20-Aug-14 00:00    PGM / RUN BY / DATE
  4.6566D-09 1.4901D-08 -5.9605D-08 -5.9605D-08     ION ALPHA
  7.9872D+04 6.5536D+04 -6.5536D+04 -3.9322D+05     ION BETA
  0.000000000000D+00 0.000000000000D+00  507904   1806 DELTA-UTC: A0,A1,T,W
  16                            LEAP SECONDS
                               END OF HEADER
 1 14 8 20 0 0 0.0 0.000000000000D+00 0.000000000000D+00 0.000000000000D+00
  0.000000000000D+00 0.000000000000D+00 0.000000000000D+00-2.625403406770D+00
  0.000000000000D+00 0.000000000000D+00 0.000000000000D+00 5.153700811000D+03
  2.592000000000D+05 0.000000000000D+00-6.436197146207D-01 0.000000000000D+00
  9.599310887001D-01 0.000000000000D+00-1.201977730000D+00 0.000000000000D+00
  0.000000000000D+00 1.000000000000D+00 1.806000000000D+03 0.000000000000D+00
  1.200000000000D+00 0.000000000000D+00 0.000000000000D+00 0.000000000000D+00
  2.592000000000D+05 4.000000000000D+00 0.000000000000D+00 0.000000000000D+00
 2 14 8 20 0 0 0.0 0.000000000000D+00 0.000000000000D+00 0.000000000000D+00
.
.
.
```

Rinex file formatting is critical – Spirent recommends you compare the example file listing above and the description of each line in the listing (given below) with the Rinex file specification in reference ii).

**Line 1**
Two columns a) and b):
Column a) Rinex version (RINEX VERSION): 2.10

Column b) Rinex Type (TYPE): N: NAV DATA GPS

**Line 2**
Three columns a) to c):
Column a) Name of program creating this file (PGM): SimGEN V5.03.00

Column b) Name of agency creating this file (RUN BY): Spirent

Column c) Date of file creation (DATE): TOC (see line 8[b]) subtracted by one hour

**Line 3**
Four columns a) to d):
(ION ALPHA): Four coefficients Alpha 0 to Alpha 3 set in **Atmosphere-Atmosphere file-Ionospheric model-**


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***Terrestrial iono model - GPS and default model*-Broadcast ionospheric model-Upload 1 (navigation data)** (page 9-3)

**Line 4**
**(**ION BETA): Four coefficients Beta 0 to Beta 3 set in **Atmosphere-Atmosphere file-Ionospheric model-*Terrestrial iono model - GPS and default model*-Broadcast ionospheric model-Upload 1 (navigation data)** (page 9-3)

**Line 5**
(DELTA UTC:): Terms to compute time in UTC
Four columns of data a) to d):

Column a) Coefficient A0 (A0) = a0 + (a1 * delta_t)

Column b) Coefficient A1 (A1) = a1

Column c) Reference time for UTC data (T) = GPS time of week for toa

Column d) UTC reference week number (W) = GPS week number for toa

Where:

delta_t: toa - Scenario_start_time

toa: Scenario start time + approximately 70 hours.
***Note**: The reference time should be modulo 4 096 so it may not be exactly 70 hours.*

a0, a1: Values of coefficients **A0** and **A1** set in **GPS-*General*** (page 10-6). Coefficients are converted from microseconds to seconds.
***Note**: Coefficient A2 is not used.*

**Line 6**
Delta time due to leap seconds (LEAP SECONDS): as set in **GPS-*General*-GPS time leads UTC by**
***Note**: You must select **Scenario-Start time-UTC offset control-legacy(constellation file)** (page 4-15) before SimGEN can read and write UTC offset, in seconds, from and to Rinex files*

**Line 7**
**(**END OF HEADER)

**Line 8 to Line 15**
These lines give GPS Navigation Data for the first satellite in the constellation. This data occupies eight rows by four columns of the file. The satellite SVID precedes the data in the first row. The Rinex file gives data for all GPS satellites present at the scenario start

This example listing identifies the columns of data as a) (first column) to d) (fourth column).

Square brackets enclose relevant units.

**Line 8**
Column a) PRN: Satellite PRN number. Value should correspond to scenario.

Column b) Epoch/ Time of Clock (TOC): Defined as the next two-hourly epoch time based on the scenario start time (unless the scenario start time is already on a two-hour epoch boundary). For example:

i) Scenario start time 10 Aug 2008 14:00:00 then TOC = 10 Aug 2008 16:00:00
ii) Scenario start time 10 Aug 2008 15:00:00 then TOC = 10 Aug 2008 16:00:00
iii) Scenario start time 10 Aug 2008 22:00:05 then TOC = 11 Aug 2008 00:00:00

Column c) SV CLOCK

T(orb_ref_time - toe ) = seconds elapsed from orbital reference time to toe (time of ephemeris)

T(orb_ref_time - toe ) = TOC(s) - scenario_start_time(s)

***Notes**:*

***1)** SV clock bias [s] = Af0 + ( Af1 * T(orb_ref_time - toe ) ) + Af2 * (T(orb_ref_time - toe ))²*

***2)** SV clock drift [s.s-1] = Af1 + 2 * ( Af2 * T(orb_ref_time - toe ) )*

***3)** SV clock drift rate [s.s-2] = Af2*

*Where:*
*Values for Af0, Af1 and Af2 are in **GPS-Motion - Clock errors*** (page 10-37)

**Line 9**
BROADCAST ORBIT 1

Column a) IODE: uses the value in **GPS-*Motion - Clock errors*** (default is 2.0)

Column b) Crs [m]: set in **GPS-*Motion - Perturbations*-Crs** (page 10-34)

Column c) Delta n [rad.$s^{-1}$]: set in **GPS-*Motion - Orbits*-Mean motion Difference (Delta N)** (page 10-21). The value in the scenario extrapolated forward by T(orb_ref_time - toe).


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Column d) M0 [rad]: set in **GPS-*Motion - Orbits*-Mean anomaly(Mo)**. The value in the scenario extrapolated forward by T(orb_ref_time - toe)

**Line 10**
BROADCAST ORBIT 2

Column a) Cuc [rad]: set in **GPS-*Motion - Perturbations*** (page 10-34).

Column b) Eccentricity (e): set in **GPS-*Motion - Orbits***.

Column c) Cus [rad]: set in **GPS-*Motion - Perturbations***.

Column d) sqrt(A) [$m^{1/2}$]: **GPS-*Motion - Orbits***. The value in scenario extrapolated forward by T(orb_ref_time - toe)

**Line 11**
BROADCAST ORBIT 3

Column a) Toe [s]: GPS time-of-week based on TOC

Column b) Cic [rad]: set in **GPS-*Motion - Perturbations***.

Column c) OMEGA [rad]: set in **GPS-*Motion - Orbits*-Longitude of ascending node(Weekly Epoch)(Wo)**. The value in scenario extrapolated forward by T(orb_ref_time - toe)

Column d) Cis [rad]: set in **GPS-*Motion - Perturbations*-Cis**

**Line 12**
BROADCAST ORBIT 4

Column a) i0 [rad]: set in **GPS-*Motion - Orbits*-Inclination(Io)**. The value in scenario extrapolated forward by T(orb_ref_time - toe)

Column b) Crc [m]: set in **GPS-*Motion - Perturbations***.

Column c) omega [rad]: set in **GPS-*Motion - Orbits*-Argument of perigee (w)**.

Column d) OMEGA DOT [$rad.s^{-1}$]: set in **GPS-*Motion - Orbits*-Right ascension rate (Wdot)**.

**Line 13**
BROADCAST ORBIT 5

Column a) IDOT [$rad.s^{-1}$]: set in **GPS-*Motion - Orbits*-Inclination rated (Idot)**.

Column b) L2 channel code: set in **GPS-*Signal Control - Upload details*-L2 channel code** (page 10-48).

Column c) GPS week: the GPS week number for TOC

Column d) L2 channel flag: set in **GPS-*Signal Control - Upload details*-L2 channel flag**.

**Line 14**
BROADCAST ORBIT 6

Column a) SV accuracy [m]: set in **GPS-*Signal Control - Upload details*-URA**. RINEX file includes the average of the range shown in the following table, which shows data from reference o). For example, a URA index of fourteen gives an SV accuracy of (614 4 + 307 2) /2 = 460 8 metres.

| URA Index | URA range (metres) | URA Index | URA range (metres) |
|---|---|---|---|
| 0 | 0.00 < URA ≤ 2.40 | 8 | 48.00 < URA ≤ 96.00 |
| 1 | 2.40 < URA ≤ 3.40 | 9 | 96.00 < URA ≤ 192.00 |
| 2 | 3.40 < URA ≤ 4.85 | 10 | 192.00 < URA ≤ 384.00 |
| 3 | 4.85 < URA ≤ 6.85 | 11 | 384.00 < URA ≤ 768.00 |
| 4 | 6.85 < URA ≤ 9.65 | 12 | 768.00 < URA ≤ 1536.00 |
| 5 | 9.65 < URA ≤ 13.65 | 13 | 1536.00 < URA ≤ 3072.00 |
| 6 | 13.65 < URA ≤ 24.00 | 14 | 3072.00 < URA ≤ 6144.00 |
| 7 | 24.00 < URA ≤ 48.00 | 15 | 6144.00 < URA<br>Or accuracy prediction is not available.<br>Unauthorised users will use the SV at their own risk |


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Column b) SV health: Corresponds to bits 17-22 in word three in subframe1 of the GPS navigation data. The MSB represents the health of the navigation data, set in: **GPS-*Signal Control - Upload details*-L1/L2 nav data health** (page 10-48).
The remaining five bits represent the signal health set in: **GPS-*Signal Control - Upload details*-L1/L2 signal health**.

Column c) Tgd [s]: set in **GPS-*Signal Control - General*-Group delay-Tgd** (page 10-40).

Column d) IODC: uses the value in ***Motion - Clock errors*-IODC** (default is 2.0) (page 10-50)

**Line 15**
BROADCAST ORBIT 7

Column a) Transmission time of message [s of GPS week]: GPS time-of-week for date found in line 2 [c] of header.

Column b) Fit interval [hours]: 4 hours

Column c) Spare

Column d) Spare

**Line 16 onward**
GPS Navigation Data Record for second, third and so on satellites.

### 10.11.1.5.2 Example GPS Rinex file - version 3.00 format

***Notes**:*

***1)** Currently, SimGEN can export data for GPS, GLONASS and Galileo satellites as Rinex version 3.00 format files - see reference jj).*
*For an example of a GLONASS Rinex file in version 3.00 format, see **Example GLONASS Rinex file - version 3.00 format** (page 11-20)*
*For an example of a Galileo Rinex file in version 3.00 format, see **Example Galileo Rinex file - version 3.00 format** (page 12-10)*

***2)** Currently, SimGEN exports Rinex files using "D" to represent the decimal exponent. Reference jj) allows the decimal exponent to be one of "d", "D", "e" or "E"*

This example file listing shows the format of the GPS Rinex version 3.00 file (the colour of the text is inverted every fifth line for readability):

```
   3.00      N: NAVIGATION DATA G: GPS       RINEX VERSION / TYPE
SimGEN V5.03.00   Spirent       20140820 000000 UTC PGM / RUN BY / DATE
GPSA  4.6566D-09 1.4901D-08 -5.9605D-08 -5.9605D-08    IONOSPHERIC CORR
GPSB  7.9872D+04 6.5536D+04 -6.5536D+04 -3.9322D+05    IONOSPHERIC CORR
GPUT 0.0000000000D+00 0.000000000D+00 507904 1806     TIME SYSTEM CORR
  16                             LEAP SECONDS
                                END OF HEADER
G01 2014 08 20 00 00 00 0.000000000000D+00 0.000000000000D+00 0.000000000000D+00
   0.000000000000D+00 0.000000000000D+00 0.000000000000D+00-2.625403406770D+00
   0.000000000000D+00 0.000000000000D+00 0.000000000000D+00 5.153700811000D+03
   2.592000000000D+05 0.000000000000D+00-6.436197146207D-01 0.000000000000D+00
   9.599310887001D-01 0.000000000000D+00-1.201977730000D+00 0.000000000000D+00
   0.000000000000D+00 1.000000000000D+00 1.806000000000D+03 0.000000000000D+00
   1.200000000000D+00 0.000000000000D+00 0.000000000000D+00 0.000000000000D+00
   2.592000000000D+05 4.000000000000D+00 0.000000000000D+00 0.000000000000D+00
G02 2014 08 20 00 00 00 0.000000000000D+00 0.000000000000D+00 0.000000000000D+00
.
.
.
```

Rinex file formatting is critical - Spirent recommends you compare the example file listing above and the description of each line in the listing (given below) with the Rinex file specification in reference jj).

Where relevant, square brackets contain the units.

**Line 1**
Three columns a) to c):
Column a) Rinex version (RINEX VERSION): 3.00

Column b) Rinex Type (TYPE): N: NAVIGATION DATA

Column c) Satellite System: G: GPS


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**Line 2**
Three columns a) to c):
Column a) Name of program creating this file (PGM): SimGEN V5.03.00

Column b) Name of agency creating this file (RUN BY): Spirent

Column c) Date and time of file creation:
Date and time format: yyyymmdd hhmmss UTC, see ***Example GPS Rinex file - version 2.10 format*** (page 10-28).

**Line 3**
Four columns a) to d):
GPSA = "GPS alpha terms"

(IONOSPHERIC CORR)

GPSA a) to d) are “Ion Alpha” terms, see ***Example GPS Rinex file - version 2.10 format*** (page 10-28).

**Line 4**
Four columns a) to d):

(IONOSPHERIC CORR)

GPSB a) to d) are “Ion beta” terms, see ***Example GPS Rinex file - version 2.10 format*** (page 10-28).**Line 5**

GPUT = GPS to UTC a0, a1 (TIME SYSTEM CORR):

Terms to compute time in UTC

Column a) Coefficient A0(A0) = a0 + (a1 * delta_t)

Column b) Coefficient A1(A1) = a1

Column c) Reference time for UTC data(T) = GPS time-of-week for toa

Column d) UTC reference week number(W) = GPS week number for toa.

Where:

delta_t = toa - Scenario start time
GPS toa, a0,a1 - see ***Example GPS Rinex file - version 2.10 format*** *(page 10-28)*

**Line 6**
Delta time due to leap seconds (LEAP SECONDS): as set in **GPS-*General*-GPS time leads UTC by**
***Note**: You must select **Scenario-Start time-UTC offset control-legacy(constellation file)** (page 10-6) before SimGEN can read and write UTC offset, in seconds, from and to Rinex files*

**Line 7**
(END OF HEADER)

**Line 8 to Line 15**
These lines contain navigation data for the first satellite in the constellation.

This data occupies eight rows by four columns of the file. The satellite SVID precedes the data in the first row, preceded by G for GPS. The Rinex file shows satellites present at the scenario start.

This example listing identifies the columns of data as a) (first column) to d) (fourth column).

***Note:** You must select <**scenario**>-Start time-UTC offset control-legacy(constellation file)** (page 4-15) before SimGEN can read and write UTC offset, in seconds, from and to Rinex files*

**Line 8**
Column a) PRN: Satellite PRN number. Value should correspond to scenario.

Column b) Epoch/ Time of Clock (TOC): Defined as the next two-hourly epoch time based on the scenario start time (unless the scenario start time is already on a two-hour epoch boundary). For example:

i) Scenario start time 10 Aug 2008 14:00:00 then TOC = 10 Aug 2008 16:00:00
ii) Scenario start time 10 Aug 2008 15:00:00 then TOC = 10 Aug 2008 16:00:00
iii) Scenario start time 10 Aug 2008 22:00:05 then TOC = 11 Aug 2008 00:00:00

Column c) SV CLOCK

T(orb_ref_time - toe ) = seconds elapsed from orbital reference time to toe (time of ephemeris)

T(orb_ref_time - toe ) = TOC(s) - scenario_start_time(s)

***Notes**:*

***1)** SV clock bias [s] = Af0 + ( Af1 * T(orb_ref_time - toe ) ) + Af2 * (T(orb_ref_time - toe ))²*

***2)** SV clock drift [s.s-1] = Af1 + 2 * ( Af2 * T(orb_ref_time - toe ) )*

***3)** SV clock drift rate [s.s-2] = Af2*


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*Where:*
*Values for Af0, Af1 and Af2 are in* ***GPS-Motion - Clock errors*** *(page 10-37)*

**Line 9**
BROADCAST ORBIT 1

Column a) IODE: uses the value in **GPS-*Motion - Clock errors*** (default is 2.0)

Column b) Crs [m]: set in **GPS-*Motion - Perturbations*-Crs** (page 10-34)

Column c) Delta n [rad.$s^{-1}$]: set in **GPS-*Motion - Orbits*-Mean motion Difference (Delta N)** (page 10-21). The value in the scenario extrapolated forward by T(orb_ref_time - toe).

Column d) M0 [rad]: set in **GPS-*Motion - Orbits*-Mean anomaly(Mo)**. The value in the scenario extrapolated forward by T(orb_ref_time - toe)

**Line 10**
BROADCAST ORBIT 2

Column a) Cuc [rad]: set in **GPS-*Motion - Perturbations*** (page 10-34).

Column b) Eccentricity (e): set in **GPS-*Motion - Orbits***.

Column c) Cus [rad]: set in **GPS-*Motion - Perturbations***.

Column d) sqrt(A) [$m^{1/2}$]: **GPS-*Motion - Orbits***. The value in scenario extrapolated forward by T(orb_ref_time - toe)

**Line 11**
BROADCAST ORBIT 3

Column a) Toe [s]: GPS time-of-week based on TOC

Column b) Cic [rad]: set in **GPS-*Motion - Perturbations***.

Column c) OMEGA [rad]: set in **GPS-*Motion - Orbits*-Longitude of ascending node(Weekly Epoch)(Wo)**. The value in scenario extrapolated forward by T(orb_ref_time - toe)

Column d) Cis [rad]: set in **GPS-*Motion - Perturbations*-Cis**

**Line 12**
BROADCAST ORBIT 4

Column a) i0 [rad]: set in **GPS-*Motion - Orbits*-Inclination(Io)**. The value in scenario extrapolated forward by T(orb_ref_time - toe)

Column b) Crc [m]: set in **GPS-*Motion - Perturbations***.

Column c) omega [rad]: set in **GPS-*Motion - Orbits*-Argument of perigee (w)**.

Column d) OMEGA DOT [rad.$s^{-1}$]: set in **GPS-*Motion - Orbits*-Right ascension rate (Wdot)**.

**Line 13**
BROADCAST ORBIT 5

Column a) IDOT [rad.$s^{-1}$]: set in **GPS-*Motion - Orbits*-Inclination rated (Idot)**.

Column b) L2 channel code: set in **GPS-*Signal Control - Upload details*-L2 channel code** (page 10-48).

Column c) GPS week: the GPS week number for TOC

Column d) L2 channel flag: set in **GPS-*Signal Control - Upload details*-L2 channel flag**.

**Line 14**
BROADCAST ORBIT 6

Column a) SV accuracy [m]: set in **GPS-*Signal Control - Upload details*-URA**. RINEX file includes the average of the range shown in the following table, which shows data from reference o). For example, a URA index of fourteen gives an SV accuracy of (614 4 + 307 2) /2 = 460 8 metres.

| URA Index | URA range (metres) | URA Index | URA range (metres) |
|---|---|---|---|
| 0 | 0.00 < URA ≤ 2.40 | 8 | 48.00 < URA ≤ 96.00 |
| 1 | 2.40 < URA ≤ 3.40 | 9 | 96.00 < URA ≤ 192.00 |
| 2 | 3.40 < URA ≤ 4.85 | 10 | 192.00 < URA ≤ 384.00 |
| 3 | 4.85 < URA ≤ 6.85 | 11 | 384.00 < URA ≤ 768.00 |
| 4 | 6.85 < URA ≤ 9.65 | 12 | 768.00 < URA ≤ 1536.00 |


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| URA Index | URA range (metres) | URA Index | URA range (metres) |
|---|---|---|---|
| 5 | 9.65 < URA ≤ 13.65 | 13 | 1536.00 < URA ≤ 3072.00 |
| 6 | 13.65 < URA ≤ 24.00 | 14 | 3072.00 < URA ≤ 6144.00 |
| 7 | 24.00 < URA ≤ 48.00 | 15 | 6144.00 < URA<br>Or accuracy prediction is not available.<br>Unauthorised users will use the SV at their own risk |

Column b) SV health: Corresponds to bits 17-22 in word three in subframe1 of the GPS navigation data. The MSB represents the health of the navigation data, set in: **GPS-*Signal Control - Upload details*-L1/L2 nav data health** (page 10-48).
The remaining five bits represent the signal health set in: **GPS-*Signal Control - Upload details*-L1/L2 signal health**.

Column c) Tgd [s]: set in **GPS-*Signal Control - General*-Group delay-Tgd** (page 10-40).

Column d) IODC: uses the value in ***Motion - Clock errors*-IODC** (default is 2.0) (page 10-50)

**Line 15**
BROADCAST ORBIT 7

Column a) Transmission time of message [s of GPS week]: GPS time-of-week for date found in line 2 [c] of header.

Column b) Fit interval [hours]: 4 hours

Column c) Spare

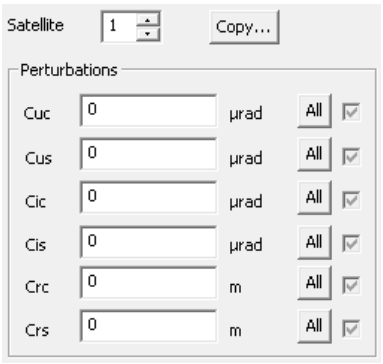
Column d) Spare

**Line 16 onward**
GPS Navigation Data Record for second, third and so on satellites.

## 10.11.2 Motion - Perturbations

***Note**: BeiDou, CAPS, Galileo, IRNSS and Quasi-Zenith constellations also use this dialog, although parameter values may not be the same*

Use this dialog to specify perturbation errors for each satellite.




| | | | |
|---|---|---|---|
| **Satellite** | Select the **Satellite** whose settings you want to change.<br>Click **Copy** to copy these parameters to the Satellites you select in the dialog. | | |
| **Cuc, Cus** | The amplitude of the cosine and harmonic correction terms to the argument of latitude - see reference a). | | |
| | Units: microradian | Range: -61.03516 to 61.03329 µrad | Default: 0 |


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| | | | |
|---|---|---|---|
| **Cic, Cis** | The amplitude of the cosine and sine harmonic correction terms to the angle of inclination - see reference a).<br>The Units, Range and Default are the same as those for **Cuc** and **Cus** | | |
| **Crc, Crs** | Amplitude of the cosine and sine harmonic correction terms to the orbit radius see reference a) | | |
| | Units: metres | Range: -1 024.0 to 1 023.0 m | Default: 0 |

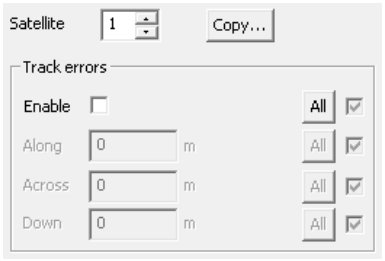
## 10.11.3 Motion - Track errors

***Notes**:*

***1)** When you enable **Track errors** or **Differential Corrections** for GPS satellites, SimGEN version 2-83 onwards generates a combined error. To maintain backwards compatibility, SimGEN automatically enables **Track errors** or **Differential Corrections**, as required, if it detects a scenario has been generated using SimGEN version 2-82 or earlier.*

***2)** The BeiDou, Galileo, GLONASS and IRNSS constellations also use this dialog, although parameter values may not be the same*

Use this dialog to specify errors in the position SimGEN simulates in the RF signal (compared to the position given by the almanac / ephemeris data in the Navigation Data message).




Click **All** to set any parameter to be the same for all satellites.

If you only use **Track errors**, SimGEN internally calculates the corresponding Differential corrections and applies them as necessary.

Spirent suggests you use either **Track errors** or **Differential corrections**, see ***Motion - Differential correction table*** (page 10-35), rather than using both **Track errors** and **Differential corrections**. However, if you enable both **Track errors** and **Differential corrections**, SimGEN internally compounds these errors to obtain a combined error, calculates the appropriate track errors and differential corrections, and applies them as necessary to the Navigation data message.

| | | | |
|---|---|---|---|
| **Enable** | Enable or disable these parameters without entering or deleting values.<br>Deselect (default): Disables these parameters for this **satellite**<br>Select: Enables these parameters for this **satellite** | | |
| **Along** | Along track error.<br>A positive value specifies a forward position in the direction of the satellite velocity vector. | | |
| | Units: metres | Range: ± 100.0 m | Default: 0 |
| **Across** | Cross-track error.<br>A positive value specifies a position 90º to the right of the track and in the WGS84 local tangential plane.<br>The Units, Range and Default are the same as those for **Along** | | |
| **Down** | Down-track error.<br>A positive value specifies a position down from the track and normal to the WGS84 local tangential plane.<br>The Units, Range and Default are the same as those for **Along** | | |

## 10.11.4 Motion - Differential correction table

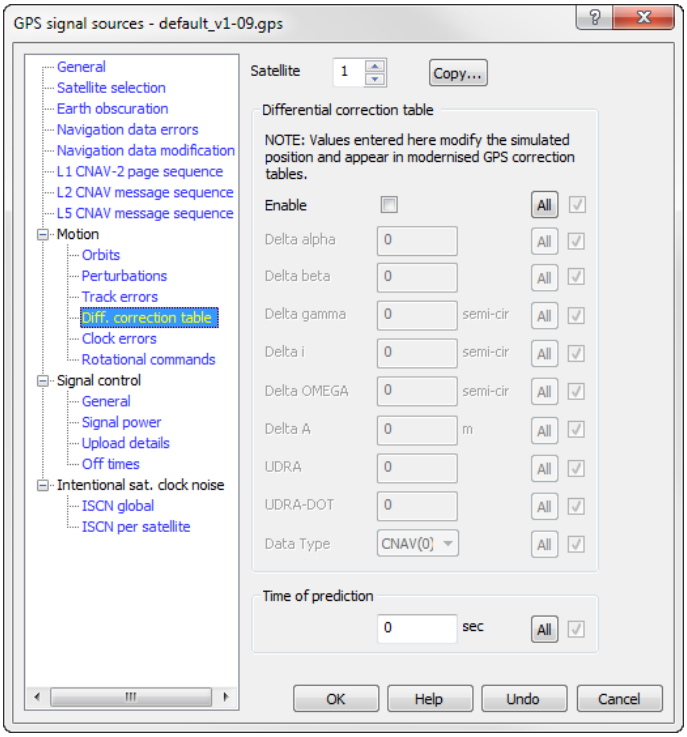
***Notes***:


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*1) When you enable **Track errors** or **Differential Corrections** for GPS satellites, SimGEN version 2-83 onwards generates a combined error. To maintain backwards compatibility, SimGEN automatically enables **Track errors** or **Differential Corrections**, as required, if it detects a scenario has been generated using SimGEN version 2-82 or earlier.*

*2) The IRNSS constellation also uses this dialog, although parameter values may not be the same*

Modernised GPS messages use Differential correction values to offset the position of the satellite.




If you enable **Track errors**, using ***Motion - Track errors*** (page 10-35), and ***Motion - Differential correction table*** (page 10-35),SimGEN generates compounded errors and inserts the compounded error value in the Navigation data message. If you only use **Differential corrections**, SimGEN internally calculates the corresponding Track errors and applies them as necessary.

Rather than using both **Track errors** and **Differential corrections**, Spirent suggests you use either **Track errors**, or **Differential corrections.** However, if you enable both **Track errors** and **Differential corrections**, SimGEN internally compounds these errors to obtain a combined error, calculates the appropriate track errors and differential corrections, and applies them as necessary to the Navigation data message.

| | | | |
|---|---|---|---|
| **Satellite** | Select the **Satellite** whose settings you want to change.<br>Click **Copy** to copy these parameters to the Satellites you select in the dialog. | | |
| **Enable** | Enable or disable these parameters without entering or deleting values.<br>Deselect (default): Disables the following parameters for this **satellite**<br>Select: Enables the following parameters for this **satellite** | | |
| **Delta alpha,**<br>**Delta beta** | Units: none | Range: ± 4.768 E-7 | Default: 0 |
| **Delta gamma** | Units: semi-circles | Range: ± 3.815 E-6 semi-circles | Default: 0 |
| **Delta I,**<br>**Delta OMEGA** | Units: semi-circles | Range: ± 4.768 E-7 semi-circles | Default: 0 |
| **Delta A** | Units: m | Range: -4 to + 3.998 metres | Default: 0 |
| **UDRA,**<br>**UDRA-DOT** | Units: none | Range: -16 to +15 | Default: 0 |
| ***Note**: If you leave any parameter beginning with 'Delta' (for example **Delta alpha**) at the default value, zero, **Data Type** is always set to **CNAV(0)*** | | | |


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| | | | |
|---|---|---|---|
| **Data Type** | Set the DC Data Type from:<br>**CNAV(0)** (default): Use for CNAV, L5-CNAV and CNAV-2<br>**NAV(1)**: Use for legacy NAV | | |
| **Time of prediction** | ***Note***: *Spirent is currently waiting for confirmation of this parameter. Spirent recommends you use the default value of 0 seconds.* | | |
| | Units: seconds | Range: 0 to 2 147 483 647 s | Default: 0 |

## 10.11.5 Motion - Clock errors

***Notes***:

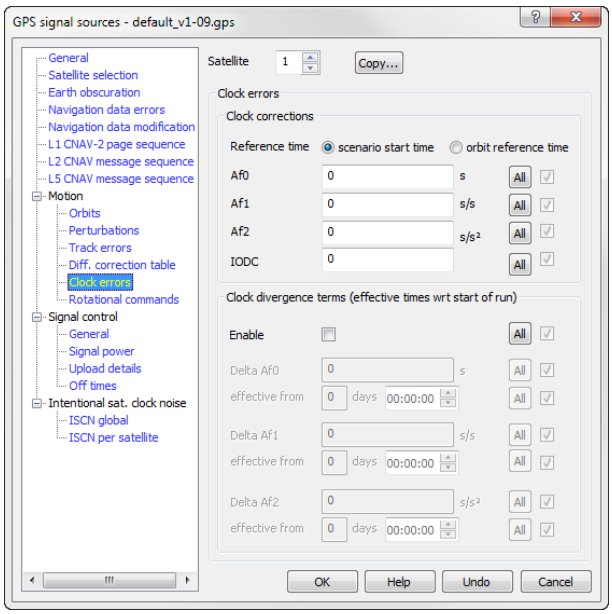
***1)*** *Setting the Delta Af0 divergence term is the same as applying a pseudorange error to that satellite.*

***2)*** *The BeiDou, CAPS, GLONASS, IRNSS and Quasi-Zenith constellations also use this dialog, although parameter values may not be the same.*

Use this dialog to specify:

**Clock corrections** - transmitted in the Navigation Data message and describe the drift of the GPS satellite's clock over time. SimGEN model clock corrections in the RF signal **AND** transmits them in the Nav Data message.

**Clock divergence terms** - these are added to the RF signal ONLY and simulate the satellite's clock drift as being different from that described in the Nav Data message (unless set to 0).




| | |
|---|---|
| **Satellite** | Select the **Satellite** whose settings you want to change.<br>Click **Copy** to copy these parameters to the Satellites you select in the dialog. |
| **Clock corrections** | Reference a) specifies the clock correction terms, which SimGEN transmits in the navigation data. They modify the timing of the simulated signals accordingly. The reference time for these parameters is the **scenario start time** or the **orbit reference time**. The modified parameters transmitted in the navigation data allow for the difference between the scenario reference time and toc/ toe. Spirent uses the clock correction equation given in reference a) to modify the signal timing. |
| **Reference time** | Up to SimGEN 2-90, SimGEN applied clock error terms relative to the **scenario start time**, instead of using the **orbit reference time**.<br>Choose from: |

| | | | |
|---|---|---|---|
| | **scenario start time** (default): references clock correction terms to the scenario start time (giving backwards compatibility). Select if you are likely to change the start time by a large amount (days) to prevent over-ranging of the clock terms.<br>**orbit reference time**: references clock correction terms to the orbital reference time. If you are performing runs with small changes in start time, relating clock terms to the orbital reference maintains continuity in clock terms between runs and duplicates the clock terms from Yuma or Rinex files. | | |
| ***Note:*** *You must select* ***<scenario name>-Start time-UTC offset control-legacy(constellation file)*** *(page 4-15) before SimGEN can read and write UTC offset, in seconds, from and to Rinex files* | | | |
| **Af0**<br>**Zero-order term** | Units: seconds | Range: ±976.562 03 E-6 s | Default: 0 |
| **Af1**<br>**First-order term** | Units: seconds per second | Range: ±3.725 18 E-9 $s.s^{-1}$ | Default: 0 |
| **Af2**<br>**Second-order term** | Units: seconds per $(second)^2$ | Range: ±3.525 E-15 $s.s^{-2}$ | Default: 0 |
| **IODC** | Sets initial value of IODC at start of scenario for **Satellite**.<br>IODE has the same start value as IODC.<br>SimGEN increments IODC and IODE with each successive upload. | | |
| **Clock divergence terms (effective times wrt start of run)** | These terms are analogous to **Af0**, **Af1** and **Af2**, but apply only to the signal timing. Navigation data does not contain corrected **Clock divergence terms**. Since **Clock divergence terms** can simulate errors in signal timing, consider them as clock or range errors.<br>To use these terms select Clock divergence terms-Enable. | | |
| **Delta Af0**<br>**Zero-order term** | Units: seconds | Range: ±25.0 E-3 s | Default: 0 |
| ***Note****: The start time for* ***Delta Af0*** *is set at 0 days 00:00:00 (start of run)* | | | |
| **Delta Af1**<br>**First-order term** | Units: seconds per second | Range: ±1.0 E-5 $s.s^{-1}$ | Default: 0 |
| ***Note****: Set the start time for* ***Delta Af1*** *using* ***Effective from*** | | | |
| **Delta Af2**<br>**Second-order term** | Units: seconds per $(second)^2$ | Range: ±1.0 E-12 $s.s^{-2}$ | Default: 0 |
| ***Note****: Set the start time for* ***Delta Af2*** *using* ***Units: none*** | | | |
| **Effective from** | Sets the start time for Delta Af1 and Delta Af2 | | |
| | Units: dd hh:mm:ss | Range:<br>0 days 00:00:00<br>to 23 days 23:59:59 | Default: 0 days 00:00:00<br>(start of run) |

## 10.11.6 Motion - Rotational commands

***Licenced feature****: You will need a licence to use this feature. Contact Spirent for licencing details.*

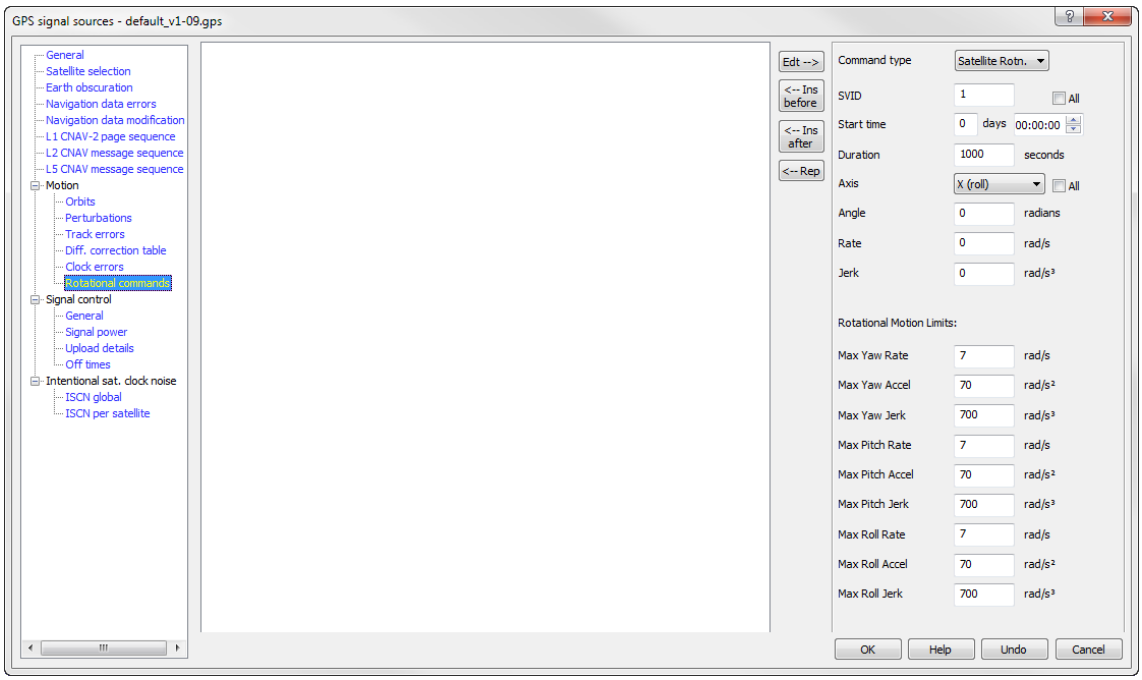
***Notes****:*

***1)*** *The Galileo constellation also uses this command*

***2)*** *Currently, only the GPS and Galileo constellations support this command*

Use this dialog to specify satellite rotation using the SimGEN List Editor. **Menus-*List Editor*** (page 5-33) describes using the List Editor.


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| | | | |
|---|---|---|---|
| **SVID** | Type the SVID you want to use or select **All** | | |
| **Start time** | Units:<br>d hh:mm:ss | Range:<br>0 days 00:00:00<br>to 23 days 23:59:59 | **Start** default:<br>0 days 00:00:00<br>(start of run) |
| **Duration** | Type the duration of the rotation you want to apply | | |
| | Units: seconds | Range: 1 to 32 000 | Default: 1 000 |
| **Axis** | Enter the **Angle**, **Rate** and **Jerk** for each **Axis**<br>Select **All** to apply the same **Angle**, **Rate** and **Jerk** to each **Axis**<br><br>Select **Axis** from:<br>**X (roll)**<br>**Y (pitch)**<br>**Z (yaw)** | | |
| **Angle** | Units: radians | Range: ±100 000π rad | Default: 0 |
| **Rate** | Units: radians per second | Range: 0 to 7 $rad.s^{-1}$ | Default: 0 |
| **Jerk** | Units: radians per $(second)^3$ | Range: 0 to 700 $rad.s^{-3}$ | Default: 0 |
| **Rotational Motion Limits** | These entries specify the maximum satellite rotational characteristics, in a similar way to a vehicle personality file (for example, the **Spacecraft-*Personality file*** (page 21-29). | | |
| **Max Yaw Rate**<br>Maximum rate of rotation around the satellite vertical axis | Units: radians per second | Range: 0 to 7 $rad.s^{-1}$ | Default: 7 |
| **Max Yaw Accel**<br>Maximum satellite structural stress acceleration | Units: radians per $(second)^2$ | Range: 0 to 70 $rad.s^{-2}$ | Default: 70 |
| **Max Yaw Jerk**<br>Maximum rate of change of vehicle structural stress acceleration | Units: radians per $(second)^3$ | Range: 0 to 700 $rad.s^{-3}$ | Default: 700 |


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| | | | |
|---|---|---|---|
| **Max Pitch Rate**<br>Maximum rate of change of vehicle elevation angle | Units: radians per second | Range: 0 to 7 $rad.s^{-1}$ | Default: 7 |
| **Max Pitch Accel**<br>Maximum acceleration in vehicle pitch angle | Units: radians per $(second)^2$ | Range: 01 to 70 $rad.s^{-2}$ | Default: 70 |
| **Max Pitch Jerk**<br>Maximum rate of change of acceleration in vehicle pitch angle | Units: radians per $(second)^3$ | Range: 0 to 700 $rad.s^{-3}$ | Default: 700 |
| **Max Roll Rate**<br>Maximum roll-rate, the rate of change of roll angle | Units: radians per second | Range: 0 to 7 $rad.s^{-1}$ | Default: 7 |
| **Max Roll Accel**<br>Maximum acceleration in roll angle | Units: radians per $(second)^2$ | Range: 0 to 70 $rad.s^{-2}$ | Default: 70 |
| **Max Roll Jerk**<br>Maximum rate of change of acceleration in roll angle | Units: radians per $(second)^3$ | Range: 0 to 700 $rad.s^{-3}$ | Default: 700 |

## 10.12 Signal Control

***Note about running GPS L2 only**:*

***1)** STR4760 and GSS7700 Variant A signal generators do not support running GPS L2 only, you must use L1 and L2.*

***2)** GSS7700 Variant A signal generators declared as GSS7700 do not allow L2 only, you must use L1 and L2.*

***3)** GSS7700 Variant B signal generators generally support L2 only. Contact **Spirent Global Services** (page 28-1) who will be able to determine if your signal generator supports L2 only.*

***4)** GSS9000-series and GSS8000-series signal generators support L2 only.*

***5)** GSS7000 signal generators support GPS P (and Pseudo-Y) code*

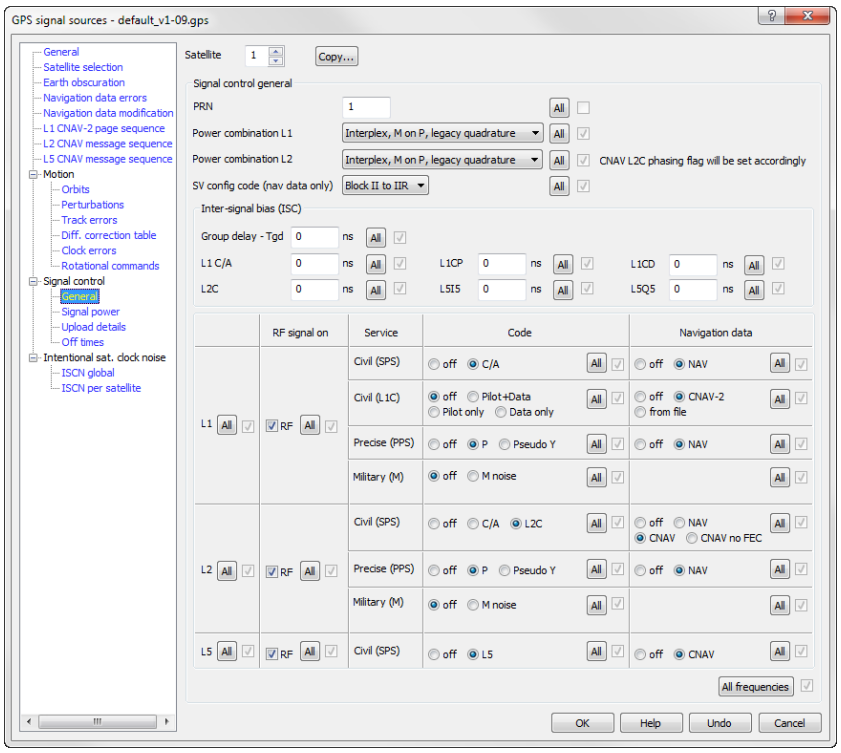
Use these dialogs to specify GPS satellite signal characteristics.

### 10.12.1 Signal Control - General

***Note**: Spirent uses the GPS ICD, reference b), definitions for **CNAV** ("original" Civil Navigation data on L2) and **CNAV-2** ("new" Civil Navigation data on L2)*

Use this dialog to specify GPS satellite signal characteristics.


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| | |
|---|---|
| **Satellite** | Select the **Satellite** whose settings you want to change.<br>Click **Copy** to copy these parameters to the Satellites you select in the dialog. |
| **Satellite control general** | |
| **PRN** | The Pseudo-Random-Noise code each **Satellite** transmits.<br>Each GPS satellite broadcasts a different Pseudo-Random sequence.<br>In a simulation, you can use two satellites with the same PRN (that is, use two satellites with identical orbits and PRNs) by using **Clock Divergence terms**, see ***Motion - Differential correction table*** (page 10-35), to modify the pseudorange on one satellite to simulate a multipath signal.<br>Normally you set **PRN** to the same number as **Satellite** (SVID), except for GPS satellites using the ***Extended GPS constellation*** (page 10-2). |
| ***Note**: Spirent recommends you only set the satellite **PRN** to be identical to **Satellite** (the satellite SVID)when using an SVID in the range 1 to 32. SVID identifies the satellite in the broadcast almanac. The ability to change PRN is useful for special test purposes, such as testing two satellites with the same PRN.* | |
| **Power combination L1** | Select the combining method and carrier for M-Code for L1:<br>** * Interplex, M on P, legacy quadrature<br>* Interplex, M on CA, legacy quadrature<br>* Additive, M on P, legacy quadrature<br>* Additive, M on CA, legacy quadrature<br>Interplex, M on P, P lags CA<br>Interplex, M on CA, P lags CA<br>Additive, M on P, P lags CA<br>Additive, M on CA, P lags CA |
| **Power combination L2** | Select the combining method and carrier for M-Code for L2:<br>** * Interplex, M on P, legacy quadrature<br>* Interplex, M on L2C, legacy quad.<br>* Additive, M on P, legacy quadrature<br>* Additive, M on L2C, legacy quadrature<br>Interplex, M on P, P lags CA<br>Interplex, M on L2C, P lags CA<br>Additive, M on P, P lags CA<br>Additive, M on L2C, P lags CA<br>Interplex, P and L2C in phase<br>Additive, P and L2C in phase |


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***Notes***:

***1)*** *GSS9000-series, GSS7000, GSS8000-series and GSS7700 signal generators support* ***Power Combination***.

***2)*** *GSS9000-series, GSS8000-series signal generators support all Power Combinations.*

***3)*** *The GSS7700 from firmware version 1-24 (Variant B), and version 1-11 (Variant A) supports all* ***Power Combinations****. Older firmware (and older signal generators) support the L1 and L2 Power Combination selections marked with * in the two figures shown above. If you select an unsupported item, a warning appears and the selection defaults to the items marked ** (highlighted text in the above figures).*

***4)*** *If you use SimMCODE, 'M' in* ***Power Combination L1*** *and* ***Power Combination L2*** *refers to AES Code - see reference tt). If you do not use SimMCODE, 'M' refers to M-Noise.*

***5)*** *If you do not use M-Code or M-Noise, your choice in* ***Power Combination L1*** *and* ***Power Combination L2*** *is not important.*
*Interplex power combining is only applicable when M-Code is present along with two legacy codes.*
*In all other cases, SimGEN uses Additive power combining.*

***6)*** *The STR4760 does not support independent channels running pseudo-Y code. If you set some STR 4760 channels running pseudo-Y code, the STR4760 will automatically run with ALL channels running pseudo-Y code. A message in the* ***System Messages*** *window warns you "All channels set to pseudo-Y code, cannot be switched individually".*

| | |
|---|---|
| **SV config code (nav data only)** | Inserts the satellite type in the SV configuration data broadcast in Subframe 4, Page 25 of the GPS Nav Data message. Choose from: |
| **Block II to IIR** | Default |
| **Block IIR-M** | |
| **Block IIF** | Only for Block IIF satellites.<br>Subframe 5, Page 25, Word 10 specifies the current calendar year. |
| **Block IIIA** | |

Set the following parameters for each **Satellite** to control generation of the GPS frequencies, their respective PRN codes and Navigation data.

You can set each **Frequency** (**L1**, **L2**, and **L5**) to use different signal configurations. For each **Frequency**, set **RF signal on**, **Service**, **Code** and **Navigation Data** to the settings you want to use.

Spirent recommends you deselect **RF signal on** to turn off specific frequencies for specific satellites in multi-frequency scenarios only.

Read the above Notes before deselecting **RF on**

***Note****: The ISC parameters apply to navigation data only.*

| | | | |
|---|---|---|---|
| **Group delay - Tgd** | Type the correction term for group delay | | |
| | Units: nanoseconds | Range: -59.64 to 59.14 ns | Default: 0 |
| **ISC (L1 C/A)** | Inter-Signal Correction (ISC).<br>SimGEN broadcasts this group delay parameter in both the L2C and L5 Navigation Data Type 3 Messages.<br><br>The Units, Range and Default are the same as those for **Group delay-Tgd** | | |
| **ISC (L2C)** | L2C supports two group delays:<br>1) between L1P and L1 C/A<br>2) between L1P and L2C.<br><br>The Units, Range and Default are the same as those for **Group delay-Tgd** | | |
| **ISC (L5I5),**<br>**ISC (L5Q5)** | L5 supports the L2C group delays plus two further group delays:<br>1) between L1 P(Y) code and L5 I5<br>2) between L1 P(Y) code and L5Q5.<br><br>The Units, Range and Default are the same as those for **Group delay-Tgd** | | |


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| | RF signal on | Service | Code | Navigation data |
|---|---|---|---|---|
| **L1** | Select (default): on<br>Deselect: RF signal off | **Civil (SPS)** | Selected (default): **C/A**<br>or select: **off** | Selected (default): **NAV**<br>or select: **off** |
| | | **Civil (L1C)** | Selected (default): **off**<br>or select from:<br>**Pilot+Data**<br>**Pilot only**<br>**Data only** | Selected (default): **off**<br>or select from:<br>**from file** see Note 6)<br>**CNAV-2** |
| | | **Precise (PPS)** | Selected (default): **P**<br>or select from:<br>**off**<br>**Pseudo Y** | Selected (default): **NAV**<br>or select: **off** |
| | | **Military (M)** | Selected (default): **off**<br>or select: **M noise** | |
| **L2** | Select (default): on<br>Deselect: RF signal off | **Civil (SPS)** | Selected (default): **off**<br>or select from:<br>**C/A**<br>**L2C** | Selected (default): **NAV**<br>or select from:<br>**off**<br>**CNAV**<br>**CNAV no FEC** |
| | | **Precise (PPS)** | Selected (default): **P**<br>or select from:<br>**off**<br>**Pseudo Y** | Selected (default): **NAV**<br>or select: **off** |
| | | **Military (M)** | Selected (default): **off**<br>or select: **M noise** | |
| **L5** | Select (default): on<br>Deselect: RF signal off | **Civil (SPS)** | Selected (default): **L5**<br>or select: **off** | Selected(default): **CNAV**<br>or select: **off** |
| **Frequency-All** | | Click to set this frequency setting to all **Satellites** (A greyed-out tick in the check box confirms this setting) | | |
| **RF signal on-All** | | Click to set this frequency's **RF signal on** for all **Satellites** (A greyed-out tick in the check box confirms this setting) | | |


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| | |
|---|---|
| **Code-All** | Click to set this **Code** setting to all **Satellites** on this frequency (A greyed-out tick in the check box confirms this setting) |
| **Navigation data-All** | Click to set this **Navigation data** setting to all **Satellites** on this frequency (A greyed-out tick in the check box confirms this setting) |
| **All frequencies** | Click to copy all settings on each **Frequency** for this **Satellite** to all **Satellites** (A greyed-out tick in the check box confirms this setting) |

***Notes**:*

***1)** By default, SimGEN sets **RF on** for each Frequency and each **Satellite** in your scenario, but you must enable the appropriate signal(s) on the antenna see for your Frequency selection to take effect, see **Receive and transmit antennas** (page 23-1)*

***2)** If your signal generator only supports L1 C/A code, selecting L1 P has no effect.*

**3)** ***M-Noise** is only available with the GSS9000-series, GSS8000-series and GSS7700 range of signal generators.*

**4)** *Selecting **Code-L2C** when using an STR4760 signal generator forces all L2 signals to operate in L2C.*

**5)** *GSS9000-series, GSS8000-series and GSS7700 signal generators support concurrent **Code-L2C**, **Code-C/A** and **Code-P**.*

**6)** *See **Format of the L1C Navigation data file** (page 10-45)*

**7)** *See **Extended GPS constellation** (page 10-2) for details on the defaults when using the upper PRN set*

***Note for single frequency scenarios and SimPLEX users**:*

*If you deselect RF on with the intention of turning off a specific Satellite, the hardware channel remains allocated to that Satellite, but with no output. Spirent recommends you turn off a specific Satellite by deselecting **Motion - Orbits-Present** (page 10-21) or use **Signal Control - Off times** (page 10-50) to switch off a Satellite for a defined period. Alternatively, use the interactive Ban or Off commands.*
*For this reason, do not deselect RF on when you generate a SimPLEX scenario.*


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### 10.12.2 Format of the L1C Navigation data file

***Note**: This file is not part of the scenario, since it is not present in the **Scenario Contents** window. This file will not transfer if you copy the scenario using SimGEN.*

You can enable automatic generation of the GPS L1C navigation data stream using the GPS constellation file editor. Alternatively, you can read this data from a user-defined file *L1C_symbol_data.txt*. The default version of this file is in the folder *…\Positioning Application\GPS L1C Nav Data*. You can define scenario-specific versions of this file and save them in the appropriate scenario folder. These versions will take precedence over the default file.

The L1C Navigation data file is a text file that defines the L1C bit-stream as a series of L1C messages. Each of these messages contains 1 800 bits (or symbols). Each message starts on an 18-second epoch in GPS time. Since each message contains a time-stamp, the message times are normally absolute. However, in the relative-time mode of operation, you can use bit-stream patterns, instead of fully-configured message content.

The format of the file is:

Reference time (**T**) seconds

<Set of nav data messages for all satellites at T >,

<Set of nav data messages for all satellites at T+18>,

<Set of nav data messages for all satellites at T+36>, and so on

For absolute message timing, the reference time (**T**) applies at the start of the first message set. This time uses the date-time format (dd-mmm-yyyy hh:mm:ss) and must correspond with an 18-second epoch in GPS time. The start time of the scenario cannot be before the reference time as there would be no L1C data defined at this time. However, the start time can be up to one hour after the reference time, provided there is at least one hour's worth of message data in the file.

If you use relative timing, set **T** equal to zero, which aligns the first message with the 18-second epoch that is immediately before, or at, the scenario start time.

Each set of Navigation data messages consists of a sequence of contiguous lines (you cannot use blank lines between consecutive file records). These lines define the L1C messages applicable at a given 18-second epoch. You must define data for each satellite with L1C enabled and you can apply the data to specific satellites or generically.

The format of the Navigation data set is:

<**SVID** for sat 1> <**nav message** for sat 1>

<**SVID** for sat 2 > <**nav message** for sat 2>

<**SVID** for sat 3> <**nav message** for sat 3>

….

<**SVID** for sat n> <**nav message** for sat n>

**SVID** is the satellite number in the GPS constellation file, which is normally equivalent to the PRN, except for GPS satellites using the ***Extended GPS constellation*** (page 10-2).

Optionally, a special case applies when you set **SVID** to zero, and the associated message applies to all satellites with L1C enabled, but without a specific navigation message.

The **nav message** data consists of 1 800 bits (symbols) represented as 450 hex characters, for example, "A" represents the bit sequence 1010.

You must separate consecutive navigation data sets (that is, successive 18-second intervals) using a blank line and provide sufficient sets to define L1C message content for the duration of your scenario.

If the message times are absolute, the scenario stops when it reaches the end of the navigation data file, but if the message times are relative, the message sequence resumes with the first set.

Lines starting with "!" are comments and are ignored.

**Example 1:**

```
! This line is a comment
24-SEP-2009 12:00:00
0 0123456789ABCDEF0123456789…….0123456789 (450 hex chars in this message)
12  12121212121212121212121212…….0123456789 (450 hex chars in this message)
21  21212121212121212121212121…….0123456789 (450 hex chars in this message)

0 0123456789ABCDEF0123456789…….0123456789 (450 hex chars in this message)
```


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```
14   12121212121212121212121212.....0123456789 (450 hex chars in this message)
21   99999999999999999999999999.....0123456789 (450 hex chars in this message)

(Further datasets follow)
```

In this example, absolute timing applies. The first data set contains specific messages for satellites 12 and 21, and a generic message for all other L1C-enabled satellites.

The second dataset contains specific data for satellites 14 and 21, and generic data for the other satellites. On reaching the end of the file, this scenario will terminate.

**Example 2:**

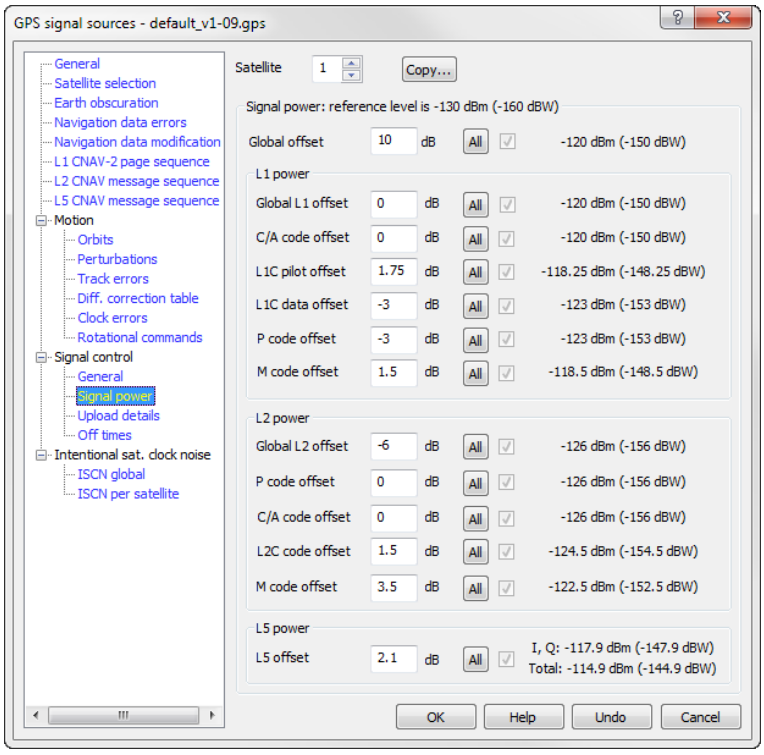
```
0
0 0123456789ABCDEF0123456789.....0123456789 (450 hex chars in this message)
0 98765432109876543210987654321.....0123456789(450 hex chars in this message)

(No more datasets)
```

In this example, the timing is relative. The messages apply to all satellites. The two messages defined in this example will loop continuously until the scenario ends.

## 10.12.3 Signal Control - Signal Power

Use this dialog to control the signal-level characteristics of all simulated carrier frequencies at the RF output of the signal generator.




If you select ***General*-Signal strength-Modelled** (page 3-15), SimGEN applies the values you enter in this dialog before performing modelling

***Note for all signal generators:***

*If you set antenna patterns using **Receive and transmit antennas** (page 23-1), and include negative figures (in other words, antenna gain) there is a possibility the sum of the RF power level you specify in the constellation file and the antenna gain will exceed the maximum power capability of your signal generator. If this occurs during a scenario, the power level will limit at the maximum capability of the signal generator. These limits are:*
*+20 dB for GSS9000-series, GSS8000-series and GSS77xx signal generators*
*+15 dB for the GSS7000, GSS6700 (and the superseded GSS6560) signal generator*

***Note for GSS9000-series, GSS7000, GSS8000-series and GSS7700 signal generators:***

*These signal generators limit the bandwidth of the GPS signal to 50 MHz (at -3 dB). The code offsets in the figure above apply before filtering, so that the offsets are the ratios of the in-band spectral densities.*


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| Code | Decrease in total power of each signal component, dB | Supported by |
|---|---|---|
| C/A and L2C | 0.0 | GSS9000-series, GSS7000, GSS8000-series and GSS7700 signal generators |
| P(Y) | 0.12 | As above |
| M-code | 0.58 | GSS9000-series, GSS8000-series and GSS7700 signal generators.<br>GSS7000 does not support M-noise |

The above table shows, for each code, the reduction in total power of each signal component due to band limiting.

| | | | |
|---|---|---|---|
| **Satellite** | Select the **Satellite** whose settings you want to change.<br>Click **Copy** to copy these parameters to the Satellites you select in the dialog. | | |
| **Global offset** | The **Global offsets** are with respect to reference a), minimum level | | |
| | Units: decibel | Range: -26.0 to +20.0 dB | Default: 10 |
| **L1 power** | L1 power settings area | | |
| **Global L1 offset** | Applies a power offset to the L1 signal. | | |
| | Units: decibel | Range: -40.0 to +0 dB | Default: 0 |
| **C/A code offset** | Sets the relative power of the C/A code component on the L1 signal | | |
| | Units: decibel | Range: -16.0 to +6.0 dB | Default: 0 |
| **L1C pilot offset** | Sets the relative power of the L1C pilot component | | |
| | Units: decibel | Range: -16.0 to +6.0 dB | Default: 1.75 |
| **L1C data offset** | Sets the relative power of the L1C data component | | |
| | Units: decibel | Range: -16.0 to +6.0 dB | Default: -3 |
| **P-code offset** | Sets the relative power of the P-code component on the L1 signal | | |
| | Units: decibel | Range: -16.0 to +6.0 dB | Default: -3 |
| **M code offset** | Sets the relative power of the M-code component on the L1 signal | | |
| | Units: decibel | Range: -16.0 to +6.0 dB | Default: 1.5 |
| ***Note for all signal generators except GSS77xx and GSS8000-series:*** *The relative code powers are pre-set to the levels specified in reference a) and SimGEN will ignore any adjustment of the power offsets, regardless of carrier frequency.* | | | |
| **L2 power** | L2 power settings areas area | | |
| **Global L2 offset** | Applies a power offset to the L2 signal | | |
| | Units: decibel | Range: -46.0 to -6.0 dB | Default: −6 |
| **P-code offset** | Sets the relative power of the P-code component on the L2 signal | | |
| | Units: decibel | Range: -16.0 to +6.0 dB | Default: 0 |
| **C/A code offset** | Sets the relative power of the C/A code component on the L2 signal | | |
| | Units: decibel | Range: -16.0 to +6.0 dB | Default: 0 |
| **L2C code offset** | Sets the relative power of the L2C code | | |
| | Units: decibel | Range: -16.0 to +6.0 dB | Default: 1.5 |


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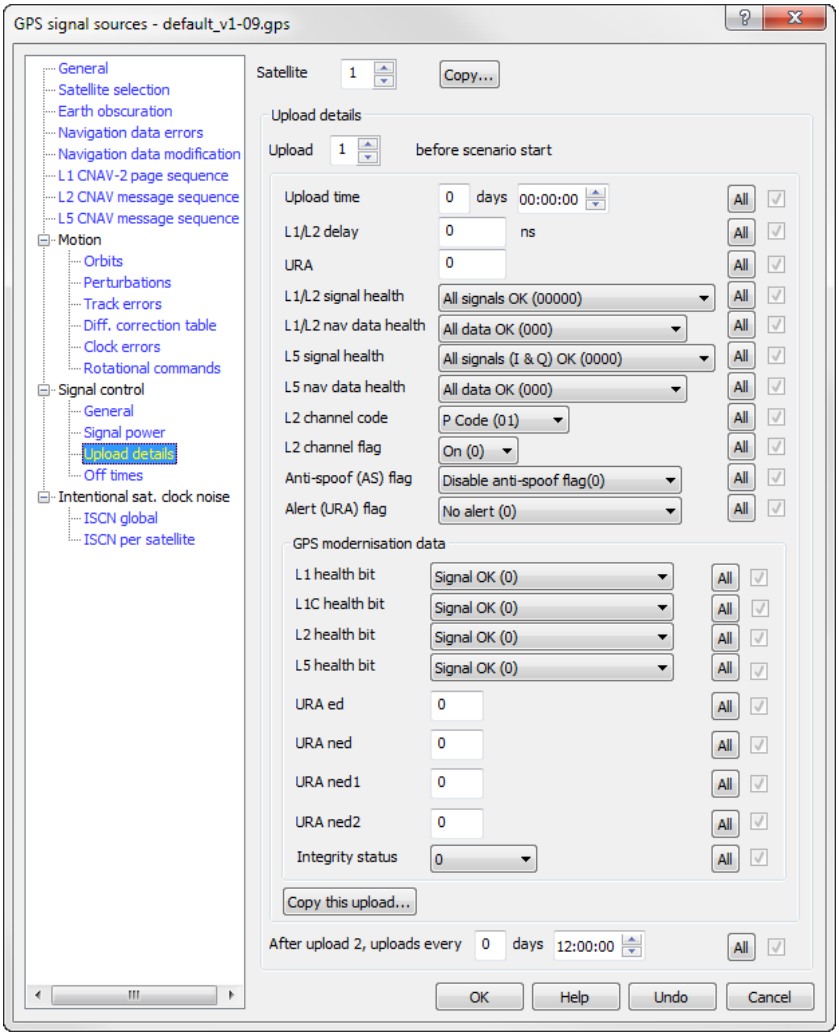
| | | | |
|---|---|---|---|
| **M code offset** | Sets the relative power of the M-code component on the L2 signal | | |
| | Units: decibel | Range: -16.0 to +6.0 dB | Default: 3.5 |
| **L5 power** | L5 power settings area | | |
| **L5 offset** | Applies a power offset to the L5 signal | | |
| | Units: decibel | Range: -37.9 to +2.1 dB | Default: 2.1 |

***Note**: L5 comprises two, equal power, quadrature, signals.*

***L5 power** sets the power of each quadrature component, so the total L5 output power is 3 dB higher than the power shown in this dialog. For example, using the default L5 offset of 2.1 dB from the reference level of -120 dBm (−130 dBm with a Global offset of 10 dB) gives the L5 power for each quadrature signal component as −117.9 dBm. The total L5 output power is then −114.9 dBm.*

## 10.12.4 Signal Control - Upload details

Use this dialog to specify the times when the ground station uploads new data to the GPS satellite.




**Upload 1** must be on or before the scenario start time, so the reference time is time BEFORE scenario start time.

**Upload 2** must be a time AFTER the scenario start time.

The navigation data message at start time will reflect the time of **Upload1**. For instance, specifying a time greater than 14 days before the scenario start-time will result in that satellite declared unhealthy.

| | |
|---|---|
| **Satellite** | Select the **Satellite** whose settings you want to change.<br>Click **Copy** to copy these parameters to the Satellites you select in the dialog. |
| **Upload time for upload 1 before scenario start** | A time, BEFORE the scenario start time<br>For the Default time, the upload is at the scenario start time. |


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| | | | |
|---|---|---|---|
| | Units:<br>days hh:mm:ss | Range: 0 00:00:00<br>to 23 23:59:59 | Default:<br>0 days 00:00:00 |
| **Upload time for upload 2 after scenario start** | A time AFTER the scenario start time.<br>If zero, a second upload will not occur during the scenario. | | |
| | Units:<br>days hh:mm:ss | Range: 0 00:00:00<br>to 23 23:59:59 | Default:<br>0 days 12:00:00 |
| Set each of the following parameters for both **Upload 1** and **Upload 2** | | | |
| **L1/L2 delay** | Only applicable if you set **Ionospheric delay-Fixed**, see ***Atmosphere file*** (page 9-1). This delay is used to calculate L1 delay:<br>L1 delay = (L1-L2 delay) / ($\gamma$ -1)<br>Where $\gamma$ is defined in reference a). | | |
| | Units: nanoseconds | Range: -120 to 240 ns | Default: 0 |
| ***Note**: Spirent defines a positive delay as L2 lagging L1* | | | |
| **URA** | Inserts the value you enter in the Navigation Data message for this upload. See reference a) for a description. | | |
| | Units: none | Range: 0 to15<br>Where:<br>0: best accuracy<br>14: worst accuracy<br>15: no accuracy prediction<br>- use at your own risk | Default: 0 |
| ***Note**: The **URA** value has no effect on the accuracy of the simulated GPS signal* | | | |
| **L1/L2 signal health** and **L5 signal health** | Select the signal health of the L1/L2 and / or L5 carriers for the duration of the upload.<br>Possible values are in the drop-down list. | | |
| ***Note**: The **signal health** value has no effect on the accuracy of the simulated GPS signal* | | | |
| **L1/L2 nav data health** and **L5 nav data health** | Select the nav data health of the L1/L2 and / or L5 carriers for the duration of the upload.<br>Possible values are in the drop-down list. | | |
| ***Note**: The **nav data health** value has no effect on the accuracy of the simulated GPS signal* | | | |
| **L2 channel code** | Select the L2 channel code bits in the navigation data message.<br>Possible values are in the drop-down list | | |
| ***Note**: Sets the data bits only, has no effect on the signal* | | | |
| **L2 channel flag** | Select the L2 P-code flag in the navigation data message. Possible values are in the drop-down list | | |
| ***Note**: Sets the data bits only, has no effect on the signal* | | | |
| **AS Flag** | See reference b) for details | | |
| **Disable anti-spoof flag (0)** | Default setting | | |
| **Enable anti-spoof flag(1)** | Forces bit 19 of the HOW word to 1, together with the appropriate bits in page 25 of subframe 4 | | |
| **Alert (URA) flag** | | | |
| **No alert (0)** | Default setting | | |
| **Alert flag set (1)** | Forces bit 18 of the HOW word to 1. | | |


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| | |
|---|---|
| **GPS modernisation data** | See reference b) for 'legacy' navigation messages and CNAV on L2C, reference c) for CNAV on L5 and reference u) for CNAV on L1C. |
| **L1 health bit to L5 health bit** | Choose from: **Signal OK (0)** (default) or **Signal bad or unavailable (1)** |
| **URAed** to **URAned2** | Type the values you want to use for each URA setting for **SVID**<br>Select **All** to use the value you type for all SVIDs |
| **Integrity status** | For **SVID**, choose from: **0** (default) or **assured (1)**<br>Select **All** to use the value you choose for all SVIDs |
| **Copy this upload...** | Click to copy these upload settings to the **Satellites** you specify in the dialog |
| **After upload 2, uploads every** | Specifies the interval (after Upload 2) at which further uploads take place.<br>These uploads use the data values you specify for Upload 2.<br>This is necessary for very long scenarios where the absence of an upload would result in the satellite health declared bad. |
| | Default: 0 days 00:00:00 |

## 10.12.5 Signal Control - Off times

***Notes**:*

***1)** If you want complete satellite obscuration (as in travelling through a tunnel), Spirent recommends you use a user action file with the **Command Type-Power Level** (see **List Editor** (page 5-33), or use the remote command POW_LEV - see reference qq).*

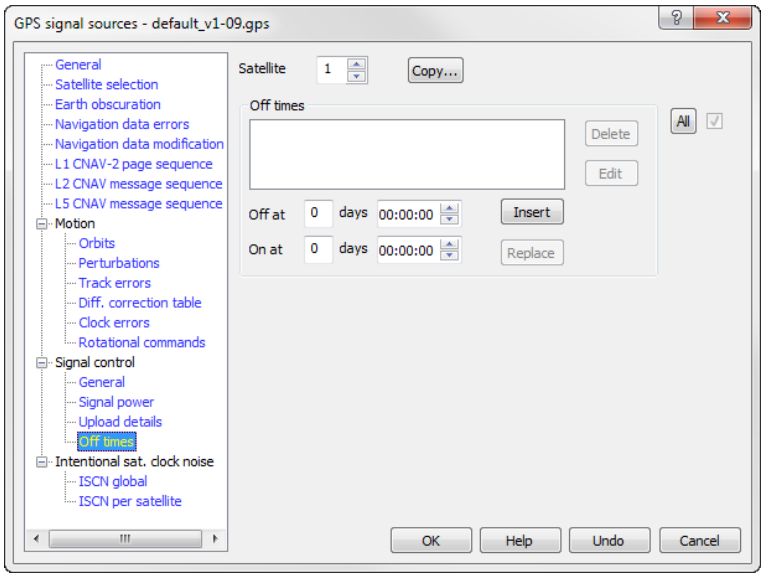
***2)** Ensure the **Off** time you enter is later than the **On** time.*

***3)** When you use the Constellation editor to set a satellite OFF at a specific time, SimGEN sets that satellite OFF in the one second (typically 0.6 seconds) before the time you specify. This ensures any replacement hardware channel starts at the correct time.*
*SimGEN does not set the satellite OFF early when you set the satellite OFF using a User Actions file.*

***4)** For the superseded GSS6560 signal generator.*
*Setting an off time (using, for example, **GPS-Signal Control - Off times** (page 10-50)) and then setting all satellites off will end the scenario at that time. If you want complete satellite obscuration (as in travelling through a tunnel), Spirent recommends you use a user action file with the **Command Type-Power Level** (see **List Editor** (page 5-33), or use the remote command POW_LEV - see reference qq).*

***5)** The BeiDou, CAPS, IRNSS, Galileo, GLONASS and Quasi-Zenith constellations also use this dialog, although parameter values may not be the same*

Use this dialog to turn off the specified GPS satellite for specific periods in a simulation:





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| | | | |
|---|---|---|---|
| **Satellite** | Select the **Satellite** whose settings you want to change.<br>Click **Copy** to copy these parameters to the Satellites you select in the dialog. | | |
| **Off at**<br>**On at** | Units:<br>days hh:mm:ss | Range: 0 00:00:00<br>to 23 23:59:59 | Default:<br>0 days 00:00:00 |

Type the **On** time and **Off** time click **Insert**. The times appear in the **Off times** area. There is no limit to the number of **On** and **Off** times.

Select a time in the **Off times** area and click **Edit** to edit the **On** / **Off** times.

Select a time in the **Off times** area and click **Replace** to replace these times with the times currently in the **Off at** and **On at** text boxes.

Select a time in the **Off times** area and click **Delete** to delete these **On** / **Off** times.

Click **All** to apply the times in the **Off times** area to all **Satellites**. A tick next to the **All** button confirms this action.

## 10.13 Intentional sat clock noise

***Notes**:*

***1)** Enabling **ISCN** contributes to pseudorange error*

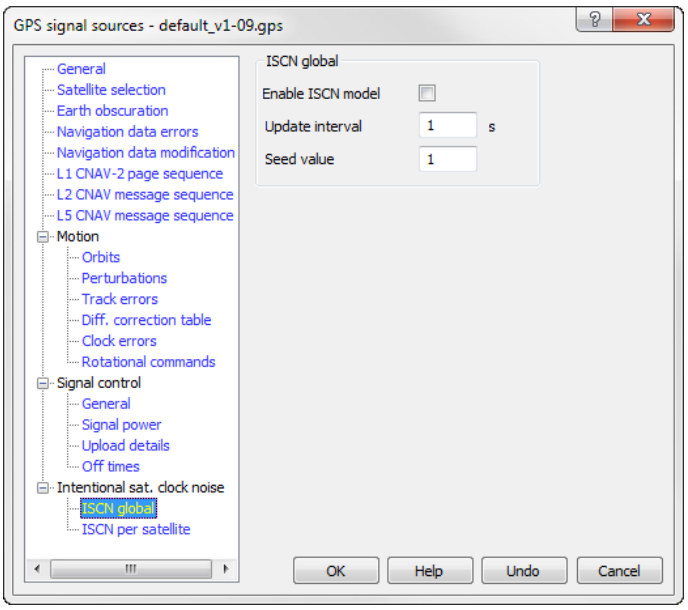
***2)** The IRNSS constellation also uses this dialog, although parameter values may not be the same*

Select **Enable ISCN model** in ***Intentional sat clock noise - ISCN global***, to set the deviation of the simulated GPS satellite clock frequency from the model you selected in ***Intentional Sat Clock Noise-ISCN per satellite*** (page 10-52). Notice this deviation is NOT included in the clock data transmitted in the Navigation data message.

### 10.13.1 Intentional sat clock noise - ISCN global

***Note**: The IRNSS constellation also uses this dialog, although parameter values may not be the same*

This figure shows the **ISCN global** dialog.




| | | | |
|---|---|---|---|
| **Enable ISCN model** | Deselect (default): Does not use the ISCN model<br>Select: Use ISCN model | | |
| **Update interval** | Type the update interval of the model. | | |
| | Units: seconds | Range: 0.01 to 60 s | Default: 1 |

| | | | |
|---|---|---|---|
| **Seed value** | Type the integer initial seed value for the model.<br>Each satellite derives individual seeds from the Seed value. The noise SimGEN applies to each satellite is different, but the noise sequences are repeatable. | | |
| | Units: none | Range: 1 to 100 | Default: 1 |

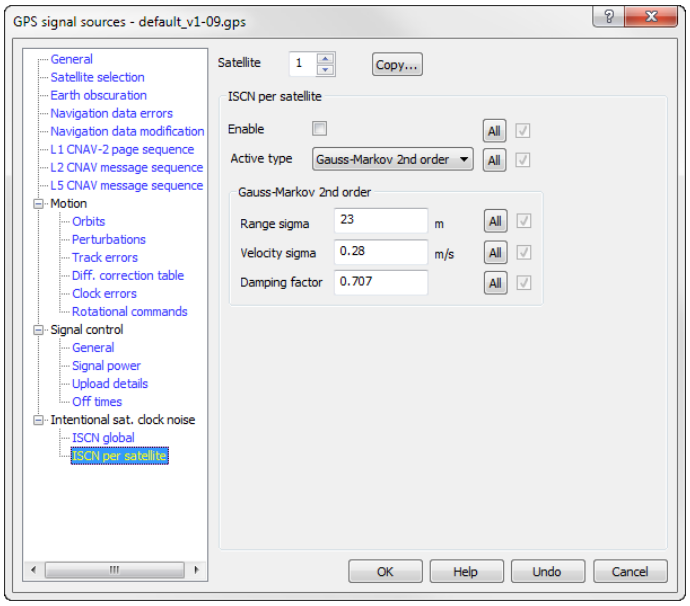
## 10.13.2 Intentional Sat Clock Noise-ISCN per satellite

***Notes**:*

***1)** The US DoD no longer applies SA degradation to GPS signals.*

***2)** The IRNSS constellation also uses this dialog, although parameter values may not be the same*

This dialog lets you add a pseudo-random error to the simulated satellite clock, which the navigation data message does not declare.




This error simulates the deliberate degrading of the commercial C/A GPS signal that was part of the Selective Availability (SA) capability. This model emulates a slowly varying position error of up to 100 metres.

Select the **Satellite** to which you want to add this error.

Select **Enable**.

Select the **Satellite** and **ISCN per satellite-Enable**. Click **All** to **Enable ISCN per satellite** for all Satellites.

This table details the ISCN models available in **Active Type**.

| Active type |
|---|
| ***Gauss-Markov 2nd order model*** (default) (page 10-53) |
| ***Gauss-Markov 1st order model*** (page 10-53) |
| ***Sinusoidal model*** (page 10-53) |
| ***Digital filter model*** (page 10-54) |

Each model outputs an error in pseudorange and pseudorange rate for the **Satellite**. This results in an equivalent shift in phase and frequency for the simulated satellite signal. The error values are available for analysis at the post-processing stage.

Click **All** to apply the **Active type** you select to all Satellites.


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#### 10.13.2.1 Gauss-Markov 2nd order model

***Note**: Spirent recommends using an update interval of 100 milliseconds for the Gauss-Markov second-order model.*

*Using longer update intervals for the Gauss-Markov second-order model can generate sampled pseudorange, leading to undesirable dynamic effects in the signal generator output.*

This is the default model for clock noise. It uses a continuous time model of the second-order Gauss-Markov process.

$$\ddot{x} + 2\beta\omega_o\dot{x}_p + \omega_o^2 x_p = (c.w)$$

Where:

$\omega_0$ is the un-damped natural frequency of oscillation
$\beta$ is the damping factor
*w* is the unity power spectral density, Gaussian white noise
c is the power spectral density

The high order of this process produces a noise function that is not discontinuous in acceleration but is discontinuous in jerk. The input parameters, range sigma ($\sigma$r), velocity sigma ($\sigma$v), and damping factor ($\beta$), determine the performance of the noise model as follows:

$$\omega_0 = \frac{\sigma_v}{\sigma_r} \qquad \omega_1 = \frac{\sigma_v}{\sigma_r}\sqrt{1-\beta^2}$$

Where:

$\omega_1$ is the output frequency.

Set the sampling interval for this model using **Intentional sat.** clock noise-ISCN global-Update interval.

| | | | |
|---|---|---|---|
| Range sigma | Units: metres | Range: 0 to 100 m | Default: 23 |
| Velocity sigma | Units: metres per second | Range: 0.01 to 10 m.s-1 | Default: 0.28 |
| Damping factor | Units: none | Range: 0.001 to 0.999 | Default: 0.707 |

#### 10.13.2.2 Gauss-Markov 1st order model

This model generates clock noise as the sum of two first-order Gauss-Markov processes, which may have different time constants and standard deviations. The initial clock noise error is a (random) constant with a value taken (randomly) from the distribution defined by the standard deviation of the first component.
The Gauss-Markov process is equivalent to a first-order version of the digital filter model.

Set the sampling interval for this model using **Intentional sat.** clock noise-ISCN global-Update interval.

| | | | |
|---|---|---|---|
| Component 1 and 2 | | | |
| Time constant | Units: seconds | Range: 0 to 1 000 s | Default: 120 |
| Std deviation | Units: metres | Range: 0 to 5 000 m | Default: 23<br>(0 for component 2) |

#### 10.13.2.3 Sinusoidal model

This model represents the ISCN term as a sinusoidal waveform with two components, both of which have fixed periods and amplitudes throughout the run, together with a start phase for each component that can only take a value of 0 or +/- 90 degrees. The following equation gives the total error in pseudorange:

Total pseudorange error (E) = E1 + E2 *Equation (1)*

Where:

$E_i = A_i \sin(\omega t + \phi i)$ *Equation (2)*

Where:

$\omega_i = 2\pi / T_i$
$\phi i = 0, +\pi/2$, or $-\pi/2$ (0°, +90°, or -90°)
$A_i$ and $T_i$ are fixed throughout.

Pseudorange rate is determined from differentiation of *Equation (2)*, for example:


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$d(E_i)/dt = A_i\omega_i\cos(\omega_i t + \phi_i)$

Set the sampling interval for this model using **Intentional sat.** clock noise-ISCN global-Update interval.

| Component 1 and 2 | | | |
|---|---|---|---|
| Fixed amplitude | Units: metres | Range: 0 to 10 000 m | Default: 0 |
| Amplitude std deviation | Units: metres | Range: 0 to 5 000 m | Default: 48<br>(14 for Component 2) |
| Period | Units: seconds | Range: 60 to 43 200 s | Default: 5 400<br>(300 for Component 2) |
| Start phase | Units: degree, minutes | Range: ± 180°,<br>0 to 60’ | Default: 0° 0' |

#### 10.13.2.4 Digital filter model

***Note**: Specify the input rate for the digital filter using **Intentional sat clock noise - ISCN global-Update interval** (page 10-51)*

This model uses a digital filter driven by zero-mean white noise to generate the clock noise waveform. It uses a filter model for SA effects, which has a transfer function taking the form:

$$H(z) = (a_0 + a_1z^{-1} + a_2z^{-2} + a_3z^{-3}) / (b_0 + b_1z^{-1} + b_2z^{-2} + b_3z^{-3})$$

Where: $a_i$ and $b_i$ are user-defined filter coefficients, for the numerator and denominator, respectively.

The input to the model is zero-mean white noise with standard deviation of $\sigma_\omega$. The output is determined using this algorithm:

$$x(k) = ( a_0w(k) + a_1w(k-1) + a_2w(k-2) + a_3w(k-3) - b_1x(k-1) - b_2x(k-2) - b_3x(k-3) ) / b_0$$

Where: w(k) is the input to the filter at time step k; for example, a sample taken from the distribution $W(0, \sigma_\omega)$ and w(k-1) the input at step k-1 and so on.
The first three output samples, for example x(0), x(1), x(2) are all zero.

| Numerators | | | |
|---|---|---|---|
| a1 | Units: none | Range: -1 000 to 1 000 | Default: 1 |
| a2 | Units: none | Range: -1 000 to 1 000 | Default: -1.5047 |
| a3 | Units: none | Range: -1 000 to 1 000 | Default: 0.6428 |
| a4 | Units: none | Range: -1 000 to 1 000 | Default: 0 |
| Denominators | | | |
| b1 | Units: none | Range: -1 000 to 1 000 | Default: 1 |
| b2 | Units: none | Range: -1 000 to 1 000 | Default: -2.0833 |
| b3 | Units: none | Range: -1 000 to 1 000 | Default: 1.2164 |
| b4 | Units: none | Range: -1 000 to 1 000 | Default: -0.1302 |
| Standard deviation | Units: metres | Range: 0 to 1 000 | Default: 5 |

Click **All** to apply the settings you make for each parameter to all Satellites.


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# 11 GLONASS constellation editor

***Notes**:*

***1)** In the GLONASS constellation file, the default setting for the Af0 term is zero. Spirent's experience is that certain receivers need to use Af0 ≥ 1 x $10^{-6}$ seconds and these receivers will fail to accept ephemeris or almanac message data from a satellite whose Af0 term is zero.*

***2)** Do not confuse GLONASS frequency channel numbers with the numbers SimGEN dynamically allocates to signal generator channels.*

***3)** GSS8000-series firmware version 2.10 and SimGEN version 2.82 SR01 onwards support GLONASS simulation at 10 and 4 milliseconds iteration rate. Previous versions only support 100 milliseconds iteration rate.*

***4)** GSS9000-series and GSS7000 signal generators support GLONASS P-code.*
*As detailed below, Spirent only supports GLONASS P-code on GSS8000-series signal generators using firmware issue 2-12 (or later).*
*A warning message appears in the **System Messages** window if you run a scenario containing GLONASS P-code with a GSS8000-series signal generator using earlier firmware (or run a scenario containing GLONASS P-code with Spirent's other GLONASS-capable signal generators).*

***5)** For backwards compatibility, SimGEN supports Spirent's obsolete GSS4780 signal generator that uses the original GLONASS channel numbers of -7 to 24. Spirent's current GSS6700 and GSS8000-series signal generators support GLONASS channel numbers -7 to 6 and Spirent recommends you only use GLONASS channel numbers -7 to 6 for new scenarios.*

SimGEN version 2-83 SR02 onwards supports GLONASS P-code for GSS8000-series signal generators only when using signal generator card firmware issue 2-12 (or later) and FPGA image release 25 (or later).

To use GLONASS P-code, you may need to upgrade the FPGA release and/or firmware issue of each signal generator card installed in your signal generator. To find the firmware version and FPGA image of your signal generator cards and then determine if your signal generator needs upgrading, Spirent recommends you follow this procedure:

- → Read the section on the menu item **Options-*Hardware Configuration*** (page 5-18), then display your signal generator configuration
- → Select your signal generator
- → Click **Output details…**
- → Contact ***Spirent Global Services*** and provide the relevant details from the configuration window.
- → Spirent Global Services will then determine if your signal generator needs upgrading and provide details on the upgrade procedure.

The GLONASS constellation editor is similar to the ***GPS constellation editor*** (page 10-1). If this Chapter on the GLONASS constellation editor does not give details for a scenario parameter, see the details for the parameter with the same name in the ***GPS constellation editor***.

The rules relating to GLONASS almanac, ephemeris and uploads are different, reference e) describes their calculation. In general, there is less ambiguity relating to this data due to the simpler message structure of GLONASS.

SimGEN calculates the position of the GLONASS satellite somewhat differently due to the different methods that GPS and GLONASS use to model the propagation of the orbital data. SimGEN defines the GLONASS constellation orbits in Keplerian terms rather than in a Cartesian frame as specified in the GLONASS ICD. However, Spirent only uses the Keplerian data to establish the position of the satellites at the start of the run. Thereafter, SimGEN propagates the orbits using the GLONASS standard Runge-Kutta fit.

SimGEN v2-81 onward gives GLONASS L2 capability. This table gives formulas for calculating GLONASS frequencies, given the channel number, k, which can range from -7 to 24, but see Note 5) above.

| GLONASS frequency | Power reference level, dBm | Channel frequency, MHz |
|---|---|---|
| L1 C/A and P | -131 | 1 602 + k * 9/16 |
| L2 C/A | -137 | 1 246 + k * 7/16 |
| L2 P | -131 | 1 246 + k * 7/16 |


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The **GLONASS constellation-GLONASS signal sources file** characterises the GLONASS satellites in a simulation. This file is often known as the “GLONASS Constellation file”, and is one of the source files defining a scenario. The default signal sources filename for the GLONASS constellation file is *default_vx-yy.glon*.

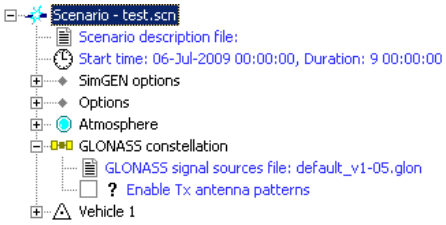
To use the GLONASS constellation, first see **Receive and transmit antennas-*Associate a GNSS signal with an antenna*** (page 23-4) and associate the appropriate signal with the antenna(s) you want to use.

## 11.1 GLONASS constellation editor

Use the constellation editor to edit data in the GLONASS constellation file. The editor shows the data in the GLONASS constellation file as a series of “pages”. The left-hand area shows the pages you can select for editing; the right-hand area shows the details of the page you selected in the left-hand area. This section describes how you select and change details in the right-hand area.

SimGEN checks the range of the value you type in a text box and, if incorrect, displays the range of acceptable values.

After associating the GLONASS signal type with an antenna, the GLONASS constellation file appears in the **Scenario contents** window:



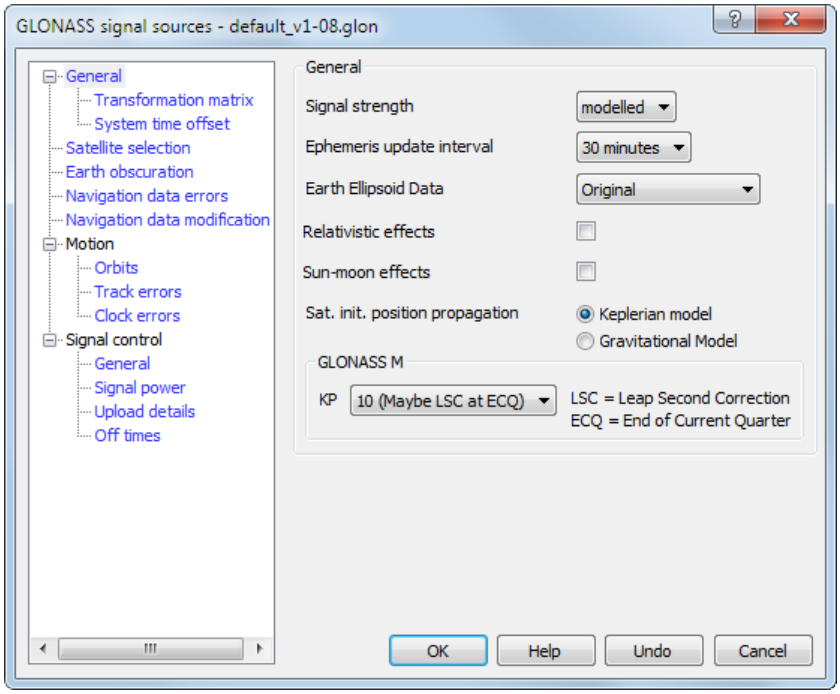

**Receive and transmit antennas-*Transmitter antenna level and phase*** patterns (page 23-20) details creating and applying **Tx antenna patterns**.

Edit the GLONASS constellation file in the same way as you would edit a GPS constellation file. First, expand **GLONASS constellation**. Then:

→ Select **GLONASS constellation-Signal sources file**

→ Right-click and select **Edit**

→ You will see the **Signal sources-General** dialog, shown below. The GLONASS signal sources file has the default name, *default_vx-yy.glon*.




The left-hand area of the **Signal sources** dialog shows the titles of all “pages” you can edit in the file. Click on a title to edit it.


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After editing the **Signal sources file**, click **OK** then save the file to a name of your choice using the dialog. Select **Shared** to save this file to the shared folder, so making it available to other scenarios.

## 11.2 Leap second

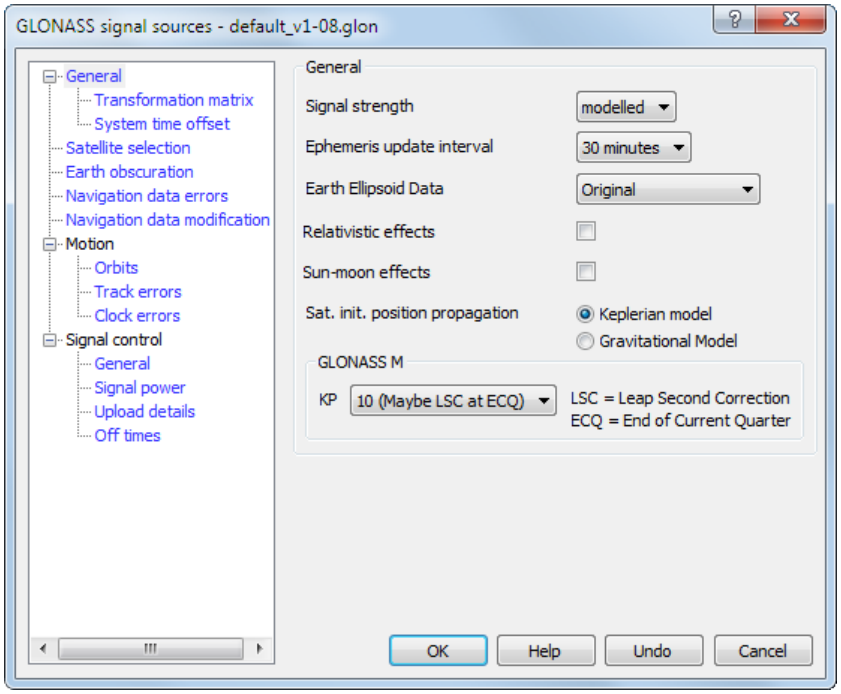
***Note**: You must set the scenario start time so the leap second occurs during the scenario*

SimGEN implements GLONASS leap second as described in reference II).

**<scenario name>-Options-*Leap second*** (page 8-1) details setting a leap second event.

## 11.3 General

Use this dialog to specify parameters for all GLONASS satellites.




| | | | |
|---|---|---|---|
| **Signal strength** | Select whether SimGEN modifies satellite signal-levels based on satellite-to-antenna distance or uses a fixed signal level. **GPS-*General - Modelled and fixed signal strength*** (page 10-6) gives further details on **Modelled** and **Fixed**. In each case, first set the base RF power level using ***Signal control - Signal power*** (page 11-25)<br><br>Choose from: | | |
| **Modelled** | (default) SimGEN modifies satellite signal level as a function of the satellite to receiver antenna distance in proportion to (distance)$^{-2}$ | | |
| **Fixed** | SimGEN does not modify the signal level as a function of satellite to receiver antenna distance. | | |
| **Ephemeris update interval** | The interval at which GLONASS satellites download updated ephemeris information | | |
| | Units: Minutes | Range: 30 or 60 minutes | Default: 30 |
| **Earth Ellipsoidal Data** | Used in the ICD definition of the GLONASS reference ellipsoid. Choose the value of the second zonal harmonic of the geopotential from:<br>**Original** (default): -1082.63E-06<br>**ICD V5 (PZ-90)**: -1082.6257E-06<br>**ICD V5.1 (PZ-90.02)**: -1082.62575E-06 | | |

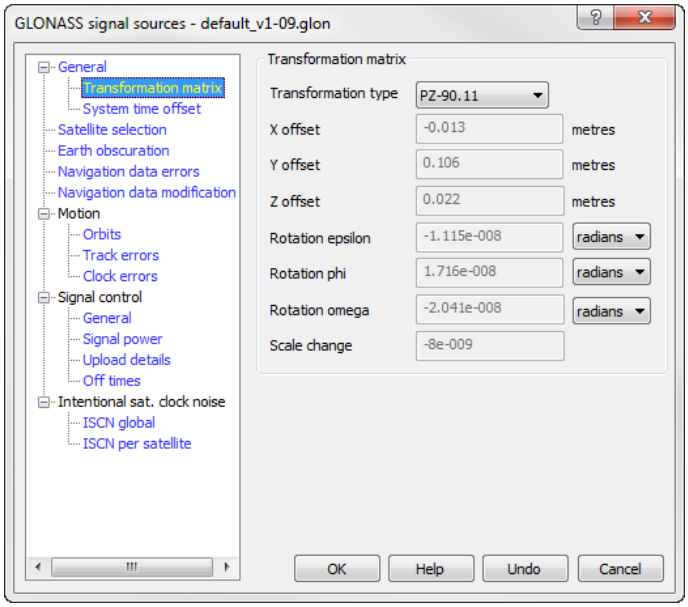

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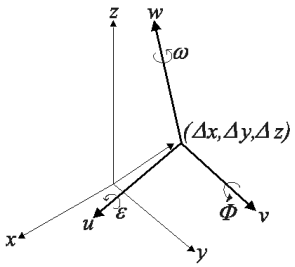
| | |
|---|---|
| **Relativistic effects** | Deselected (default): SimGEN does not use relativistic effects.<br>Select: SimGEN transforms the position and velocities of the satellite to orbital parameters and then determines the relativistic clock corrections.<br>SimGEN applies the clock corrections to the clock terms in the ephemeris message, using:<br>gamma: clock correction rate, $s.s^{-1}$<br>tau: clock correction offset, s |
| **Sun-moon effects** | Deselected (default): SimGEN does not determine gravitational effects from the Sun or Moon<br>Select: SimGEN determines gravitational accelerations from the Sun and Moon and then propagates these for position and velocity calculations.<br>SimGEN adds this acceleration to the GLONASS ephemeris message.<br>SimGEN uses J2000 for the ECI reference frame. |
| **Sat. init. position propagation** | Select the method SimGEN uses to calculate satellite positions at the scenario start time.<br><br>Choose from: |
| **Keplerian model** | (default) SimGEN uses the Keplerian orbital data you specify in ***Motion - Orbits*** (page 11-9) to calculate a new Keplerian data set that is referenced to the scenario start time.<br>The Keplerian orbital data may include large time differences between the scenario start time and the orbital reference time.<br>This model does not produce the same satellite position at a given time of day whatever the simulation start time.<br>This is a quick method. |
| **Gravitational model** | SimGEN calculates the position of each satellite at the orbital reference time you specify in ***Motion - Orbits*** (page 11-9). SimGEN then uses this model to both propagate the XYZ position to the scenario start time and propagate satellite positions during the simulation.<br>For each satellite, this model produces the same satellite position at a given time of day whatever the simulation start time, whereas using **Keplerian model** does not.<br>Notice this model uses an iterative method that may be very slow when the orbit reference time and the scenario start time are far apart. SimGEN will display a warning message if the orbit reference time and the scenario start time differ by more than one day, in which case the satellite positions will be invalid.<br>Spirent recommends you select this option if you need to get repeatable results (for a given time-of-day) across simulations where the scenario start time changes between runs. |
| **GLONASS** | |
| **KP** | Gives notification of forthcoming leap second events - see reference e).<br><br>**LSC** refers to Leap Second Correction<br>**ECQ** refers to End of Current Quarter<br>Choose from:<br>**10 (Maybe LSC at ECQ)** (default)<br>**00 (No LSC at ECQ)**<br>**01 (LSC + 1s at ECQ)**<br>**11 (LSC - 1s at ECQ)**<br><br>Regardless of your selection in this dialog, if you select a date in **Option-*Leap second*** (page 8-1), SimGEN sets **KP** to **01** when a leap second occurs in the quarter. Otherwise, SimGEN sets **KP** to the value you choose. |

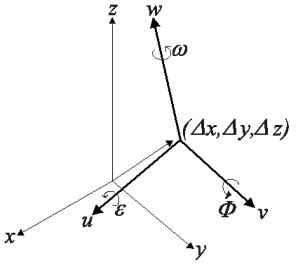

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### 11.3.1 General - Transformation matrix

Use this dialog to specify the transformation matrix SimGEN uses during translation between the WGS-84 co-ordinate frame and the Russian PZ-90 co-ordinate frame.

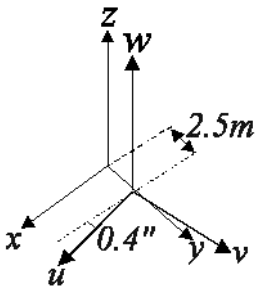



| | |
|---|---|
| **Transformation type** | Select the transformation matrix SimGEN uses during translation between WGS-84 (x, y, z) and PZ-90 (u, v, w) co-ordinate frames. Choose from: |
| **PZ90.11** | The default transformation<br>The figure below shows the PZ-90.11 transformation from PZ-90 co-ordinates (u,v,w) to WGS-84 co-ordinates (x,y,z).<br>It is a **Generic Helmert** transformation with fixed X, Y, Z offsets, fixed rotations about each of the three axes and a fixed scaling factor, as shown in the dialog. |
| |  |
| **PZ90.02** | The figure below shows the PZ-90.02 transformation from PZ-90 co-ordinates (u,v,w) to WGS-84 co-ordinates (x,y,z).<br>It is a **Generic Helmert** transformation with fixed X, Y, Z offsets and all other parameters set to zero, as shown in the dialog. |

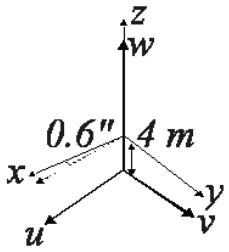



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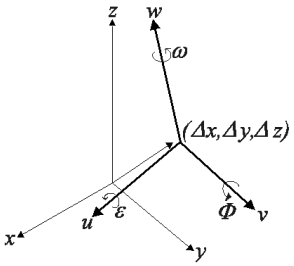
| | |
|---|---|
| **MIT** | Assigns the values given in reference e), and shown in the dialog.<br>The figure below shows the MIT transformation from PZ-90 co-ordinates (u,v,w) to WGS-84 co-ordinates (x,y,z). |




| | |
|---|---|
| **Rossbach** | Assigns the values given in reference gg), and shown in the dialog.<br>The figure below shows the Rossbach transformation from PZ-90 co-ordinates (u,v,w) to WGS-84 co-ordinates (x,y,z) |




| | |
|---|---|
| **Generic Helmert** | The figure below shows the Generic Helmert transformation from PZ-90 co-ordinates (u,v,w) to WGS-84 co-ordinates (x,y,z). |




| Type values for the seven **Generic Helmert** parameters given below.<br>Only the Generic Helmert Transformation uses these parameters, which define the offset from the centre of the WGS-84 co-ordinate frame and the PZ-90 co-ordinate frame. | | | |
|---|---|---|---|
| **X Offset,**<br>**Y Offset,**<br>**Z Offset** | Units: metres | Range: -1 E +10<br>to +1 E +10 m | Default: 0 |
| **Rotation Epsilon**<br>(Differential rotation around PZ-90 u-axis)<br>**Rotation Phi**<br>(Differential rotation around PZ-90 v-axis)<br>**Rotation Omega**<br>(Differential rotation around PZ-90 w-axis) | Units: selectable from Radians (default) or arcseconds | Range: -0.000 1<br>to +0.000 1 rad<br>(-20.63<br>to +20.63<br>arcseconds) | Default: 0 |

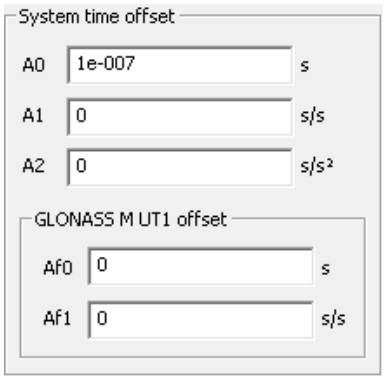

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| | | | |
|---|---|---|---|
| **Scale Change (Differential scale factor)** | Units: none | Range: -0.000 1 to +0.000 1 | Default: 0 |

### 11.3.2 General - System time offset

***Note**: If your scenario uses dual GPS and GLONASS signals, Spirent assumes there is negligible difference between* UTC(SU) *and* UTC(USNO)*. In practice, the divergence between the two is typically within the range ±10 nanoseconds.*

Use this dialog to model the offset between the GLONASS time reference system UTC(SU) and UTC(GPS) time. Divergence between the two time systems is referenced to the start of the simulation run.




| | | | |
|---|---|---|---|
| **System time offset** | Offset between GLONASS system time and UTC (SU) | | |
| **A0** (Zero-order term) | Units: seconds | Range: -0.025 to +0.025 s | Default: 1E-007 |
| **A1** (First-order term) | Units: seconds per second | Range: -1 E -5 to +1 E -5 $s.s^{-1}$ | Default: 0 |
| **A2** (Second-order term) | Units: seconds per $(second)^2$ | Range: -1 E -12 to +1 E -12 $s.s^{-2}$ | Default: 0 |
| **GLONASS M UT1 Offset** | Clock offset terms for GLONASS-M satellites | | |
| ***Note**: These terms relate to the GLONASS-M Nav data words B1 and B2, as follows:*<br>*B1 = Af0 + (Af1 * time into current run)*<br>*B2 = Af1* | | | |
| **Af0** (Zero-order term) | Units: seconds | Range: -0.025 to +0.025 s | Default: 0 |
| **Af1** (First-order term) | Units: seconds per second | Range: -1 E -5 to +1 E -5 $s.s^{-1}$ | Default: 0 |

## 11.4 Satellite selection

This dialog is the same as **GPS-*Satellite selection*** (page 10-10).

## 11.5 Earth obscuration

Use this dialog to determine how SimGEN calculates GLONASS satellite obscuration by the Earth's surface, it is the same dialog as in **GPS-*Earth obscuration*** (page 10-11).

## 11.6 Navigation data errors

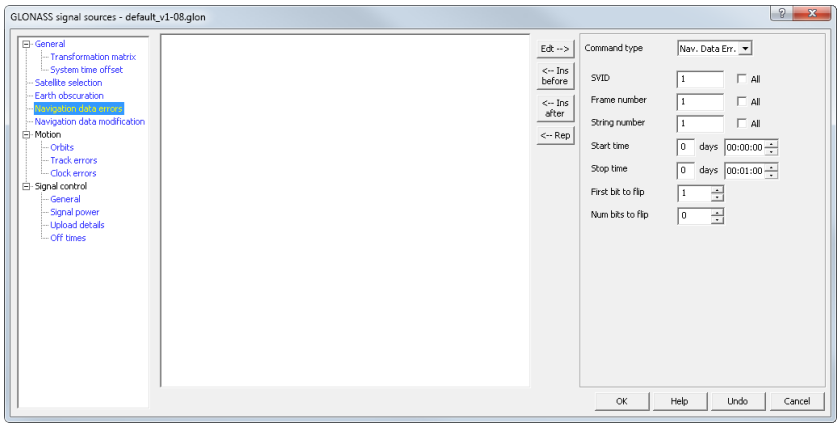
***Notes**:*

***1)**SimGEN calculates parity BEFORE making the changes, so SimGEN transmits data with incorrect parity. This tests the error detection and correction algorithms of your receiver.*


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***2)*** *To see the Help file topic on Navigation data errors for this constellation, Spirent recommend you select the Help topic from the* ***SimGEN Help-Contents*** *tab; clicking* ***Help*** *or pressing F1 on your keyboard may display an invalid Help topic.*

Use the SimGEN ***List Editor*** (page 5-33) to insert errors into the navigation data message transmitted by one or more satellites after addition of the 100 Hz meander sequence (bi-binary code).



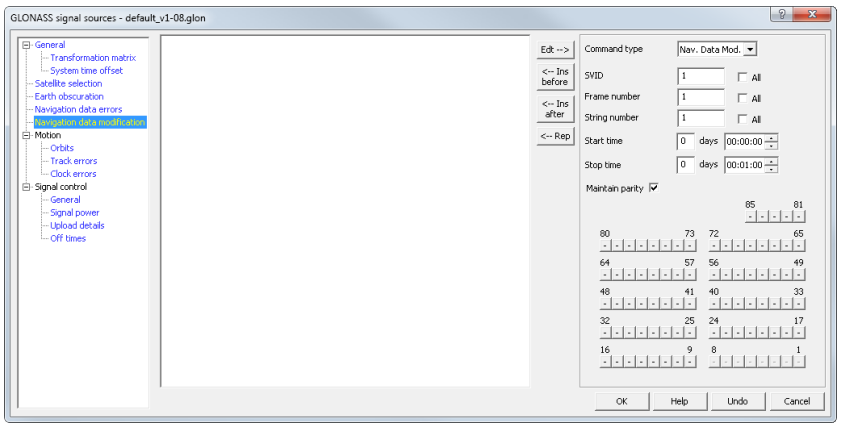

| | | | |
|---|---|---|---|
| **SVID** | Type the SVID you want to use or select **All** | | |
| **Frame number** | Type the number of the data frame in which you want the bit errors to take effect, or select **All** to apply the bit errors to all **Frame numbers**. | | |
| | Units: none | Range: 1 to 5 | Default: 1 |
| **String number** | Type the number of the data string in which you want the bit errors to take effect or select **All** to apply the bit errors to all **String numbers**. | | |
| | Units: none | Range: 1 to 15 | Default: 1 |
| **Start time**, **Stop time** | Units: d hh:mm:ss | Range:<br>0 days 00:00:00<br>to 23 days 23:59:59 | Default: 0 days 00:00:00 (Start time)<br>Default: 0 days 00:01:00 (Stop time) |
| **First bit to flip**<br>Type the first bit in the sequence to be inverted (flipped). | Units: none | Range: 1 to 200 bits | Default: 1 |
| **Number of bits to flip** Type the length of the inverted (flipped) bit sequence | Units: none | Range: 0 to 200 bits | Default: 0 |
| ***Note****: In this context, "bits" refer to the broadcast bi-binary code (symbols)* | | | |

## 11.7 Navigation data modifications

***Note****: To see the Help file topic on Navigation data modifications for this constellation, Spirent recommend you select the Help topic from the* ***SimGEN Help-Contents*** *tab; clicking* ***Help*** *or pressing F1 on your keyboard may display an invalid Help topic.*

Use the SimGEN ***List Editor*** (page 5-33) to modify the actual Navigation Data bit-stream before the addition of the 100 Hz meander sequence.


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| | | | |
|---|---|---|---|
| **SVID** | Type the SVID you want to use or select **All** | | |
| **Frame number** | Type the number of the data frame in which you want the bit modifications to take effect or select **All** to apply the bit errors to all **Frame numbers**. | | |
| | Units: none | Range: 1 to 5 | Default: 1 |
| **String number** | Type the number of the data string in which you want the bit modifications to take effect or select **All** to apply the bit errors to all **String numbers**. | | |
| | Units: none | Range: 1 to 15 | Default: 1 |
| **Start time**, **Stop time** | Units: d hh:mm:ss | Range:<br>0 days 00:00:00<br>to 23 days 23:59:59 | Default: 0 days 00:00:00 (Start time)<br>Default: 0 days 00:01:00 (Stop time) |
| **Maintain parity** | GLONASS receivers have the capability to detect infrequent bit errors and reject the affected frames by calculating the parity of the frame and comparing with the Hamming code bits.<br>Select (default): SimGEN determines the Hamming code after applying the Navigation data modifications. This allows you to change the content of the Navigation data message that SimGEN generates.<br>Deselect: SimGEN determines the Hamming code before applying the Navigation data modifications. In this case, your receiver should detect and correct the error.<br>Modify the data bits using the buttons in the dialog. This table (page 10-16) details the symbols on each button.<br>The default is “leave bit as is”. | | |

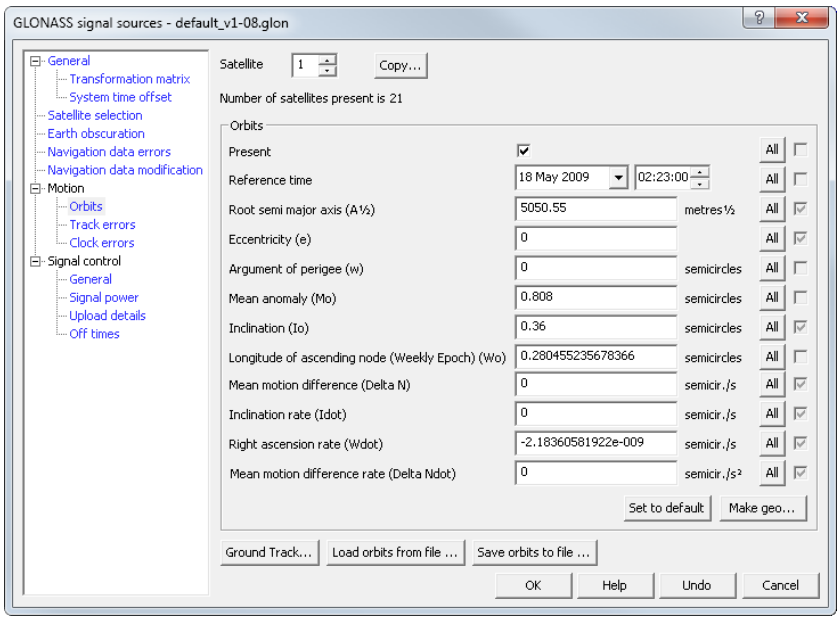
## 11.8 Motion

Use these dialogs to specify satellite Motion.

### 11.8.1 Motion - Orbits

Use this dialog to specify orbital parameters for each satellite.


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SimGEN models GLONASS satellite orbits using GPS-style parameters, referenced to the GLONASS co-ordinate frame. The dialog shows the parameters for the satellite identified by the **Satellite**. As you scroll through the satellites, using the left and right arrow buttons on the right-hand side of the **Satellite** number, the orbital parameters alter accordingly.

Click **All** to set any parameter to be the same for all satellites.

Reference a) defines all the terms in the dialog (see above).

| | | | |
|---|---|---|---|
| **Satellite** | The satellite ID for which data is currently shown | | |
| **Present** | Select (default): includes **Satellite** in the scenario<br>Deselect: treats **Satellite** as non-existent and does not include it in the Navigation data almanac set. | | |
| **Reference time** | Reference date and time in UTC (SU) at which orbit details are valid. This time is analogous to toe in the GPS satellite data message. | | |
| | Units: d hh:mm:ss.ss | Range: 06 January 1980 00:00:00.00<br>to 23 January 2048 00:00:00.00 | Default: 01 January 1991 00:00:00.00 |
| ***Note**: If the orbit terms such as **Inclination rate** or **Right ascension rate** are non-zero, you must consider the difference between **Reference time** and the **Scenario start time**. A large time difference can cause the orbits to diverge significantly, giving unexpected results. Normally, **Reference time** should be close to the scenario start time* | | | |
| **Root semi major axis (A½)** | Units: metres$^{½}$ | Range: 2 537.0<br>to 6 557.0 m½ | Default:<br>5 047.5736 7455 (gives orbit period specified in reference a) |
| **Eccentricity (e)** | Units: none | Range: 0 to 0.2 | Default: 0 |
| **Argument of perigee (w)** | Units: semi-circles | Range: -1 to +1 semi-circle | Default: 0 |
| **Mean anomaly (Mo)** | Units: semi-circles | Range: -1 to +1 semi-circle | Default: Reference a) defines the defaults for the first 21 Satellites |
| Inclination (Io) | Units: semi-circles | Range: -1 to +1 semi-circle | Default: 0.36 |
| ***Note**: Inclination outside the range 0.2375 to 0.362498 semi-circles will exceed the range of almanac δi.*<br>*The simulation will limit δi to the maximum or minimum value as appropriate with the result the almanac data will be inaccurate.* | | | |


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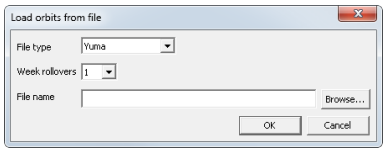
| | | | |
|---|---|---|---|
| **Longitude of ascending node (Weekly Epoch) (Wo)** | Units: semi-circles | Range: -1 to +1 semicircle | Default: Reference a) defines the defaults for the first 21 Satellites |
| ***Note**: The reference time for Wo is the weekly epoch at or before the orbit reference time.* | | | |
| **Mean motion difference (Delta N)** | Units: semi-circles per second | Range: -3.725 29 E-9 to +3.725 177 E-9 semicircles.$s^{-1}$ | Default: 0 |
| **Inclination rate (Idot)** | Units: semi-circles per second | Range: -0.931 322 78 E-9 to +0.931 208 89 E-9 semicircles.$s^{-1}$ | Default: 0 |
| ***Note**: When there is a large difference between **Reference Time** and the start of the scenario, use **Inclination rate** with caution. Extrapolation of the ephemeris over a long period could cause a significant change in inclination angle and may exceed the range of almanac δi (see **Inclination**).* | | | |
| **Right ascension rate (Wdot)** | Units: semi-circles per second | Range: -0.953 674 28 E-6 to +0.953 674 2 E-6 semicircles.$s^{-1}$ | Default: -2.183 605 819 22E-9 |
| ***Note**: When there is a large difference between **Reference Time** and the start of the scenario use **Right ascension rate** with caution. Extrapolation of the ephemeris over a long period could cause a significant change in **Longitude of ascending node*** | | | |
| **Mean motion difference rate (Delta Ndot)** | Units: semi-circles per $(second)^2$ | Range: ±2.273 736 754 43 E-13 semicircles.$s^{-2}$ | Default: 0 |

The buttons in the **Motion-Orbits** dialog are identical to those for GPS satellites, see **GPS-*Motion - Orbits*** (page 10-21).

### 11.8.1.1 Load orbits from file

***Note**: SimGEN calculates the equivalent GPS **Motion-Orbits** parameters from the parameters in the **GLONASS almanac**, **GLONASS RSA** or **GLONASS AGL** files.*

Orbital data for satellites is available for download in different formats, for example, from the Russian RSA website ftp.glonass-ianc.rsa.ru/MCC/ALMANAC. SimGEN lets you load GLONASS orbital data in Yuma, GLONASS Almanac, GLONASS RSA, GLONASS AGL or Rinex formats using this dialog:




Before reading an orbital data file, SimGEN disables all GLONASS satellites and selects the satellites in the orbital file as ***Motion - Orbits*-Present** (page 11-9).

| | |
|---|---|
| **File type** | This table (page 11-17) gives the effects of using various orbital files.<br>Select from: |
| **Yuma** | (default)<br>SimGEN sets all satellites defined in a Yuma file as **Present**.<br>The Yuma file format lets you load GLONASS almanacs using the equivalent GPS almanac definition for the Yuma files generated by the US Coastguard at www.navcen.uscg.gov.<br>SimGEN uses an ASCII format text file and recognises all extensions on the downloads available from this website. |
| **TLE** | **GPS-Motion-Orbits-*Load orbits from file*** (page 10-25) gives more details on the TLE file format |


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| | |
|---|---|
| ***Note**: Currently, you can download TLE format files for the GLONASS constellation from:* http://www.celestrak.com/NORAD/elements/glo-ops.txt *(To use this file in SimGEN, you must change its extension to *.tle)* | |
| **GLONASS Almanac** | Disables **Week Rollovers**<br>This GLONASS almanac data file uses a Spirent-defined format, which has a similar format to GPS Yuma files, but in this case contains the parameters in the broadcast GLONASS almanac, assigned with appropriate labels.<br>***GLONASS*** Almanac file (page 11-12) details the parameters in this file.<br>The GLONASS almanac file is a plain text file with extension **.glo_alm*. |
| **GLONASS RSA** | Disables **Week Rollovers**<br>The GLONASS RSA data file has almanac datasets in numeric format only. It does not use labels.<br>***GLONASS RSA file*** (page 11-14) details the parameters for this file in the order they appear in the file. In the file, a space separates each parameter.<br>The format and content of the GLONASS RSA data file that Spirent defines here is compatible with the daily bulletins available on www.glonass-ianc.rsa.ru/en/ (currently, this website references the GLONASS Almanac page as 'Ephemeris').<br>The GLONASS RSA file is a plain text file with extension **.glo_rsa* |
| **GLONASS AGL** | Disables **Week Rollovers**<br>The GLONASS AGL data file has almanac datasets in numeric format only. It does not use labels.<br>***GLONASS AGL file*** (page 11-16) details the parameters for this file in the order they appear in the file. In the file, a space separates each parameter.<br>The format and content of the GLONASS AGL data file that Spirent defines here is compatible with the daily bulletins available on www.glonass-ianc.rsa.ru/en/ (download these files from the Archive tab).<br>The GLONASS AGL file is a plain text file with extension **.agl* |
| **Rinex** | Disables **Week Rollovers**<br>References ii) (Rinex version 2.10) and jj) (Rinex version 3.0) specify the Rinex formats that SimGEN currently supports.<br>Spirent recommends you ensure the Rinex format files you use comply exactly with the requirements in the Rinex specifications<br>The Rinex file is a text file with the standard Rinex extension **yyn*. |
| ***Note**: If you load a Rinex file with more than one dataset for a satellite, SimGEN loads the most recent dataset (this is the dataset closest to the bottom of the file) and ignores all preceding datasets.*<br><br>***Note when reading from Rinex files:** You must select <**scenario name**>-**Start time**-**UTC offset control**-**legacy(constellation file)** (page 4-15) before SimGEN can read UTC offset, in seconds, from Rinex files. If you do not select **legacy(constellation file)**, SimGEN will use the value you entered in **Scenario**-**Start time**-**fixed** or the value in history.txt if you selected <**scenario name**>-**Start time**-**automatic*** | |
| **Week rollovers** | Available only for **File types-Yuma**<br>The GPS week number rolls over to zero after a period of 1024 weeks from the start of service, with the first rollover occurring on 22nd August 1999.<br>However, there is an ambiguity, as most Yuma almanac files use modulo 1024 for week numbers. Consequently, an almanac set for week number 1 might be for 1980 or 1999.<br>Selecting the appropriate **Week rollover** defines the period for the almanac data.<br>**Week rollover-1** defines the 1024-week period starting 22nd August 1999. |
| | Units: none / Range: 0 to 5 / Default: 1 |
| **Filename** | Click **Browse...** and navigate to the location of the orbital file to use |

### 11.8.1.1.1 GLONASS Almanac file

***Notes for the GLONASS almanac file**:*

***1)** You can define only one set of data for each valid satellite.*

***2)** SimGEN will disable satellites not included in the GLONASS almanac file.*

***3)** You must strictly adhere to the formats this section describes and correctly duplicate all parameter names with the correct case.*


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Below is an example GLONASS almanac file:

```
Satellite_ID:     2
Reference_date:   22.09.2008
N4_year:     4  (but N4_year will be ignored as Reference_date is given)
N_day:    266  (but N_day will be ignored as Reference_date is given)
H_n:      24
lambda_n:    -0.5
t_lambda_n:    14400
i_n:      0.01
T_n:      40500
T_dot_n:     0.1
epsilon_n:      0.01
omega_n:     -0.1
tau_n:    -1.0e-4
C_n:      1
```

| Parameter name | Description, [units] and format | Comment |
|---|---|---|
| Satellite_ID | satellite / slot<br>[number]<br>format = nn | |
| Reference_date | date of almanac,<br>format = dd.mm.yyyy | You can define the reference time of the dataset in “date” or “year/day” format.<br>If you supply the reference date, you can omit N4_year and N_day (if you include them, they are ignored).<br>If you do not define the reference date, you must specify N4_year and N_day. |
| N4_year | four year interval<br>format = nn | |
| N_day | day<br>[number in 4 year period]<br>format = nnnn | |
| H_n | carrier frequency<br>[number]<br>format = nn | The nominal range for H_n in the GLONASS Navigation data is 1 to 31.<br>H_n values 1 to 23 represent equivalent frequency channel numbers<br>H_n values 25 to 31 represent frequency numbers in the range -7 to -1.<br>SimGEN allows channel frequency numbers -7 to 24. SimGEN will accept H_n values in the range -7 to +31 in the context of the GLONASS almanac file and convert to valid channel frequencies as required. |
| lambda_n | longitude of ascending node<br>[semi-circles]<br>format = floating-point | |
| t_lambda_n | time of longitude ascending node<br>[seconds]<br>format = floating-point | |
| i_n | orbit inclination<br>[semi-circles]<br>format = floating-point | The broadcast value of i_n is an offset (range +/-12 degrees) to the nominal orbit inclination of 63 degrees. SimGEN automatically detects if the value you specify is an offset or the absolute inclination value. |


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| Parameter name | Description, [units] and format | Comment |
|---|---|---|
| T_n | orbit period<br>[seconds]<br>format = floating-point | The broadcast almanac parameter (ΔTn) is the correction to the mean value of the “nominal” orbital period (43 200 seconds = 12 h). SimGEN automatically detects if the value you specify is an offset value (range ±3 600 seconds) or the absolute value of the orbital period. |
| T_dot_n | rate of change of orbit period [seconds per orbit]<br>format = floating point | |
| epsilon_n | orbit eccentricity<br>format = floating point | |
| omega_n | argument of perigee [semi-circles]<br>format = floating point | |
| tau_n | satellite clock correction<br>[seconds]<br>format = floating point | |
| C_n | satellite health | Good = 1, Bad = 0 |

#### 11.8.1.1.2 GLONASS RSA file

***Notes**:*

***1)** You can define only one set of data for each valid satellite*

***2)** SimGEN will disable satellites not included in the GLONASS RSA file or with incomplete almanac data*

***3)** SimGEN sets all enabled satellites as healthy*

***4)** Each line in the GLONASS RSA file consists of the satellite number, followed by the parameters in the order shown in the “Parameter name (for reference)” column of the table below, separated by spaces. You must use the format shown in this table*

***5)** The current RSA almanac file format incorporates the date for each satellite. The previous file format used to incorporate the date for the whole file. SimGEN supports both formats.*

To generate an almanac file, Spirent suggests you copy the GLONASS almanac table from the RSA web site, paste this data into a text file and save the file using the extension **.glo_alm*.

The format of the GLONASS RSA almanac file is:

Line1: The text “GLONASS ALMANAC”

Line 2: Blank

Lines 3 to n: Each line must contain a complete set of almanac data.
SimGEN discards any line containing incomplete almanac data or extra data.
The first two characters in each line must be the satellite number.
The remaining parameters in each line must be in the order shown in the “Parameter name (for reference)” column of the following table, and separated by spaces

An example of a current GLONASS RSA almanac file:

```
GLONASS ALMANAC

NSDate   TW Trev   e   i   LW w   dt2 nl DT  (This line is ignored)
0112.10.11  18930.469 40544.11  0.00049   64.48093  -159.25781-38.21045 1.7929077E-4  1   -3.6621094E-4
0212.10.11  24171.625 40544.12  0.00048   64.24643  178.76799 -49.48242 2.593994E-4   -4  -4.272461E-4
0312.10.11  1621.1562 40544.15  0.00196   65.81233  32.57017  161.66931 -6.484985E-5  -6  -1.8310547E-4
```


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```
0412.10.11  34773.53  40542.477 0.00028   64.7724   14.361191 -169.53552-6.1035156E-5 -5  2.4414062E-4
0512.10.11  39176.125 40544.094 0.00013   64.468735 116.10489 33.744507 1.6784668E-4  1   -2.4414062E-4
0612.10.11  3699.4375 40544.164 0.00069   64.462555 -95.64989 154.89624 6.484985E-5   -4  -4.272461E-4
0712.10.11  9170.1875 40543.906 0.00049   63.4101   -122.213806   156.84631 2.0217896E-4  5   -4.8828125E-4
0812.10.11  13858.56254 40544.08  0.00035   64.24231  -138.14398-75.7012943.0517578E-5  6   -3.6621094E-4
0912.10.11  17142.125 40544.094 0.00196   65.03247  -31.138   21.225586 3.8146973E-5  -2  -1.2207031E-4
1012.10.11  21898.469 40544.117 0.002     65.81233  -52.11691 162.83936 8.392334E-5   -7  -1.2207031E-4
1112.10.11  27028.125 40544.09  0.00152   65.45355  -73.45201 1.5490723 7.247925E-5   0   -1.2207031E-4
1212.10.11  32325.625 40544.055 0.00385   65.03024  -94.56894 164.94873 1.449585E-4   -1  -6.1035156E-5
1312.10.11  37328.188 40544.1   0.00071   65.441025 -116.50589124.65088 3.2043457E-4  -2  0.0
1412.10.11  1909.3438 40544.062 0.0018    65.44446  31.482697 7.267456  1.9454956E-4  -7  -1.8310547E-4
1512.10.11  7434.125  40544.58  0.00201   65.81233  8.27631   -6.7126465-6.866455E-5  0   -1.8310547E-4
1612.10.11  12098.5   40544.133 0.00247   65.01445  -10.090599151.50696 3.0517578E-5  -1  -1.2207031E-4
1712.10.11  15506.781 40543.992 0.00166   64.868706 95.820694 3.2189941 2.5177002E-4  4   1.8310547E-4
1812.10.11  20555.406 40543.914 0.0024    64.79455  74.014206 -14.7052  3.4332275E-5  -3  3.0517578E-4
1912.10.11  25560.625 40543.906 0.00024   64.880554 53.55217  99.19556  1.7547607E-4  3   1.2207031E-4
2012.10.11  30780.156 40543.945 0.00128   64.89377  31.780357 0.8514404 7.6293945E-5  2   1.8310547E-4
2112.10.11  35678.22  40543.887 0.00206   64.80228  10.866852 170.39795 7.6293945E-5  4   2.4414062E-4
2212.10.11  176.125   40543.82  0.00319   64.77944  159.00067 1.9445801 -1.9073486E-5 -3  4.8828125E-4
2312.10.11  5299.0312 40543.883 0.00046   64.76193  137.59003 98.95386  3.2424927E-4  3   4.8828125E-4
2412.10.11  10296.219 40543.816 0.00097   64.77189  116.71085 91.77429  4.9591064E-5  2   4.8828125E-4
```

| Parameter name (for reference) | Description, [units] and format | Comment |
|---|---|---|
| NS | satellite number<br>[number]<br>format = nn | |
| Date | Date (UTC + 3)<br>Format= dd.mm.yy | |
| TΩ | Equator time<br>[seconds]<br>format = floating-point | |
| Trev | orbit period<br>[seconds]<br>format = floating-point | The correction to the mean value of the “nominal” orbital period (43 200 seconds = 12 h).<br>SimGEN automatically detects if the value you specify is an offset value (range ± 3 600 seconds) or the absolute value of the orbital period. |
| e | orbit eccentricity<br>format = floating-point | |
| i | orbit inclination<br>[degrees]<br>format = floating-point | An offset (range +/-12 degrees) to the nominal orbit inclination of 63 degrees.<br>SimGEN automatically detects if the value you specify is an offset or the absolute inclination value. |
| LΩ | longitude of ascending node<br>[degrees]<br>format = floating point | |
| ω | argument of perigee<br>[degrees]<br>format = floating point | |
| δt2 | satellite clock correction<br>[seconds]<br>format = floating point | |


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| Parameter name (for reference) | Description, [units] and format | Comment |
|---|---|---|
| nl | carrier frequency [number]<br>format = nn | The range for the GLONASS Navigation data is 1 to 31.<br>Values 1 to 23 represent equivalent frequency channel numbers<br>Values 25 to 31 represent frequency numbers in the range -7 to -1.<br>SimGEN allows channel frequency numbers -7 to 24.<br>For almanac files, SimGEN accepts values in the range -7 to +31, converting to valid channel frequencies as required. |
| ΔT | rate of change of orbit period [seconds per orbit]<br>format = floating point | |

To maintain compatibility with older format RSA almanac files, SimGEN continues to support the previous version of the GLONASS RSA file:

```
GLONASS ALMANAC for 13.10.2008

NS TW Trev e i LW w dt2 nl DT(This line is ignored)
01 31892.469 40543.58 0.00113 63.994434 -179.75589 156.23108 0.0 7 7.9345703E-4
02
03
04 6149.4062 40543.453 0.00382 64.118546 -71.02833 81.49109 -1.7166138E-4 6 0.0010375977
05
06 17001.688 40543.42 0.00436 64.10292 -116.39894 101.101685 2.4032593E-4 1 6.1035156E-4
07 22155.5 40543.77 0.00063 63.98894 -139.09756 157.15393 1.296997E-4 5 8.544922E-4
08 27209.344 40543.727 0.00036 64.0013 -160.16573 166.62964 0.0 6 7.324219E-4
09 30556.906 40543.92 0.00059 64.851364 -52.49508 96.47644 3.5858154E-4 -2 -1.8310547E-4
10 35483.875 40543.934 0.00209 65.250305 -73.706245 160.89478 1.487732E-4 4 -2.4414062E-4
11 121.28125 40543.887 0.00173 64.8627 74.67493 7.300415 2.3651123E-4 0 -1.2207031E-4
12
13 10323.625 40543.92 0.00082 64.85051 32.045918 117.3999 2.1362305E-4 -2 -1.8310547E-4
14 15194.906 40543.906 0.00186 65.2352 11.0500145 158.64807 1.2207031E-4 4 -1.8310547E-4
15 20365.0 40543.996 0.00226 65.233826 -10.556145 -0.087890625 -7.6293945E-5 0 -1.8310547E-4
16
17 28990.0 40544.04 0.00175 64.91231 73.78143 179.26941 2.4032593E-4 -1 -6.1035156E-5
18
19 39129.875 40544.027 0.00013 64.89617 31.400127 65.59387 7.247925E-5 3 -1.2207031E-4
20 3672.8125 40544.086 0.00148 64.91008 179.57462 -5.7788086 6.1035156E-5 2 -4.272461E-4
21
22
23 19002.969 40544.113 0.00082 64.884674 115.76311 2.9663086 7.247925E-5 3 -3.0517578E-4
24 24358.469 40543.82 0.00189 64.90304 93.41246 -12.689209 4.9591064E-5 2 1.2207031E-4
```

### 11.8.1.1.3 GLONASS AGL file

***Notes**:*

***1)** You can define only one set of data for each valid satellite.*

***2)** SimGEN will disable satellites not included in the GLONASS almanac file.*

***3)** You must strictly adhere to the formats the table in this section describes. You must correctly duplicate all parameter names with the correct case.*

This is an example GLONASS AGL file, for the first two satellites only:

```
15 06 2009  1986
 2  1 1 15 06 2009 0.334415000E+05 0.000000000E+00 0.000000000E+00 0.000000000E+00
-0.4092875E+00 0.9528160E-02 -0.8230591E-01 0.1659393E-03 -0.2655723E+04 0.3051758E-03
15 06 2009  1990
 3  5 1 15 06 2009 0.384966875E+05 0.000000000E+00 0.000000000E+00 0.495910645E-04
-0.5265713E+00 0.9570122E-02 -0.9627686E+00 0.1764297E-03 -0.2655797E+04 0.3051758E-03C_n:            1
```


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| Line and Parameter | Description | Comment with format [units] |
|---|---|---|
| Line 1: | Date as dd, mm, yyyy, ? | ? is an unknown parameter |
| Line 2: | | |
| Parameter 1 | Satellite slot number, n | Format = nn |
| Parameter 2 | Frequency number, Nl | Format = nn |
| Parameter 3 | Health | Good = 1, Bad = 0 |
| Parameter 4 | Day | Format = dd |
| Parameter 5 | Month | Format = mm |
| Parameter 6 | Year | Format = yyyy |
| Parameter 7 | Tw | Equator time |
| Parameter 8 | ? | Unknown parameter, always zero? |
| Parameter 9 | ? | Unknown parameter, always zero? |
| Parameter 10 | dt2 | clock correction [s] |
| Line 3: | | |
| Parameter 1 | Lw | Longitude of ascending node at Tw [semi-circles] |
| Parameter 2 | i | Correction of inclination at Tw [semi-circles] |
| Parameter 3 | w | Argument of perigee at Tw [semi-circles] |
| Parameter 4 | e | eccentricity at Tw |
| Parameter 5 | Trev | Correction to mean Draconian period [s.(orbit period)$^{-1}$] |
| Parameter 6 | DT | Rate of change correction to mean Draconian period [s.(orbit period)$^{-2}$] |

The following table shows, for each of the Yuma and GLONASS file formats, the satellite dependent parameters that are updated on an upload.

***Note**: Spirent recommends you set to zero all data for any parameter not updated.*

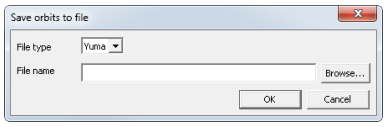
| Satellite dependent parameter | Yuma | GLO almanac | GLO RSA | GLO AGL | Rinex |
|---|---|---|---|---|---|
| Reference Time | ✓ | ✓ | ✓ | ✓ | ✓ |
| Root Semi-Major Axis (A½) | ✓ | ✓ | ✓ | ? | ✗ |
| Eccentricity (e) | ✓ | ✓ | ✓ | ✓ | ✗ |
| Argument of Perigee (w) | ✓ | ✓ | ✓ | ✓ | ✗ |
| Mean Anomaly (Mo) | ✓ | ✓ | ✓ | ? | ✗ |
| Inclination (Io) | ✓ | ✓ | ✓ | ? | ✗ |
| Longitude of Ascending Node (Wo) | ✓ | ✓ | ✓ | ? | ✗ |
| Right Ascension Rate (Wdot) | ✓ | ✓ | ✓ | ? | ✗ |


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| Satellite dependent parameter | Yuma | GLO almanac | GLO RSA | GLO AGL | Rinex |
|---|---|---|---|---|---|
| Clock Correction Term (Af0) | ✓ | ✓ | ✓ | ? | ✓ |
| Clock Correction Term (Af1) | ✓ | set to zero | set to zero | ? | ✓ |
| Clock Correction Term (Af2) | ✗ | set to zero | set to zero | ? | ✗ |
| Nav Data Health (Upload 1 and 2) | ✗ | ✗ | ✗ | ? | ✗ |
| Mean Motion Difference (Delta N) | ✗ | ✓ | ✓ | ? | ✗ |
| Mean Motion Difference rate (Delta N dot) | ✗ | ✓ | ✓ | ? | ✗ |
| Inclination Rate (Idot) | ✗ | set to zero | set to zero | ? | ✗ |
| Perturbation errors (Cuc, Cus, Cic, Cis, Crc, Crs) | ✗ | n/a | n/a | ? | ✗ |
| Track Errors (Along, Across, Down) | ✗ | n/a | n/a | ? | ✗ |
| Group delay (Tgd) | ✗ | n/a | n/a | ? | ✗ |
| Satellite signal health | ✓ | ✓ | ✓ | ✓ | ✓ |
| Position, Velocity and Acceleration | ✗ | ✗ | ✗ | ✗ | ✓ |

### 11.8.1.2 Save orbits to file

Use this dialog to save GLONASS orbital data to a file.




| File type | |
|---|---|
| **Yuma** | (default)<br>This is an ASCII text file. Spirent recommends you save this file using the extensions **.txt* or **.alm* |
| **TLE** | This is an ASCII text file using the extension **.tle*.<br>**GPS-Motion-Orbits-*Load orbits from file*** (page 10-25) gives more details on the TLE file format |
| **Rinex** | Enables **Version**<br>Rinex files are text files that you must save with the standard Rinex extension **.yyn* - see reference ii) |

***Note when writing to Rinex files:*** *The value SimGEN uses for UTC offset depends on your selection in* ***Scenario-Start time-UTC offset control****, as follows:*

***-fixed****: SimGEN writes the value your entry for* ***UTC offset*** *to the Rinex file*

***-automatic****: SimGEN writes the value from the history.txt file it uses*

***-Legacy (constellation file)****: With a GLONASS-only scenario, this value is zero unless you also define, in the same scenario, a GPS constellation with a non-zero entry in the GPS dialog* ***General-GPS time leads UTS by*** *(page 10-6)*


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| | |
|---|---|
| **Version** | Enabled only when you select **Rinex**<br>**2.10** (default): ***Example GLONASS Rinex file - version 2.10 format*** lists an example file using this version and a description of the file contents<br>**3.00**: ***Example GLONASS Rinex file - version 3.00 format*** (page 10-6) lists an example file using this version and a description of the file contents |
| **Filename** | Click **Browse...** and navigate to the location where you want to save the new orbital file |

#### 11.8.1.2.1 Example GLONASS Rinex file - version 2.10 format

***Notes***:

***1)*** *Currently, SimGEN can export data for GPS and GLONASS satellites as Rinex version 2.10 format files - see reference ii)*
*For an example of a GPS Rinex file in version 2.10 format, see* ***Example GPS Rinex file - version 2.10 format*** *(page 10-28)*

***2)*** *Currently, SimGEN exports Rinex files using "D" to represent the decimal exponent. Reference ii) allows the decimal exponent to be one of "d", "D", "e" or "E"*

This example file listing shows the format of the GLONASS Rinex version 2.10 file (the colour of the text is inverted every fifth line for readability):

```
   2.10           N: NAV DATA GLONASS           RINEX VERSION / TYPE
SimGEN V5.03.00    Spirent       20-Aug-14 00:30    PGM / RUN BY / DATE
 2014    8   20   1.000000000000D-07          CORR TO SYSTEM TIME
  16                             LEAP SECONDS
                                 END OF HEADER
 2 14  8 19 23 45  0.0 5.000000000000D-04 0.000000000000D+00 8.460000000000D+04
  1.219915764609D+04 7.858563142424D-01 0.000000000000D+00 0.000000000000D+00
  7.761267510964D+03 2.769521304887D+00 0.000000000000D+00 1.000000000000D+00
  2.101441553344D+04-1.479151950131D+00 0.000000000000D+00 0.000000000000D+00
 3 14  8 19 23 45  0.0 5.000000000000D-04 0.000000000000D+00 8.460000000000D+04
  6.703824401162D+03 6.316559783363D-01 0.000000000000D+00 0.000000000000D+00
  -1.320405760175D+04 2.774647753869D+00 0.000000000000D+00 5.000000000000D+00
  2.076956896490D+04 1.559940950853D+00 0.000000000000D+00 0.000000000000D+00
.
.
.
```

Rinex file formatting is critical - Spirent recommends you compare the example file listing above and the description of each line in the listing (given below) with the Rinex file specification in reference ii).

Where relevant, square brackets contain the units.

**Line 1**
Two columns a) to b):
Column a) Rinex version (RINEX VERSION): 2.10

Column b) Rinex Type (TYPE): N: NAV DATA GLONASS

**Line 2**
Three columns a) to c):
Column a) Name of program creating this file (PGM): SimGEN V5.03.00

Column b) Name of agency creating this file (RUN BY): Spirent

Column c) Date and time of file creation: See ***Start time*** (page 4-15) and ***General*****-Ephemeris update interval** (page 11-3) (DATE)

**Line 3**
CORR TO SYSTEM TIME

Column a) Time of reference for system time correction: Scenario start time

Column b) Correction to system time scale (TauC): ***General*****-Ephemeris update interval-System time offset-Af0**, see (page 11-3)

**Line 4**
Delta time due to leap seconds (LEAP SECONDS): as set in the **GPS-*General*-GPS time leads UTC by** (page 10-6). Set to zero if GPS constellation is not present in the Scenario

***Note****: You must select* ***Scenario-Start time-UTC offset control-legacy(constellation file)*** *(page 4-15) before SimGEN can read and write UTC offset, in seconds, to and from Rinex files*


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**Line 5**
**(**END OF HEADER)

**Line 6 to Line 9**
These lines contain GLONASS Navigation Data for the first satellite in the constellation. This data occupies four rows by four columns of the file. The satellite SVID precedes the data in the first row. The Rinex file includes data for all satellites present at the start of the scenario.

This example listing identifies the columns of data as a) (first column) to d)(fourth column).

**Line 6**

Column a) PRN: GLONASS Satellite PRN, prefixed with 'R' to specify the GLONASS Constellation. Value should correspond to scenario.

This is followed by:

(EPOCH): TOC (Time of Clock) Defined as the Scenario start time + half of the ephemeris update interval

Column b) SV clock bias (-TauN) set in ***Motion - Clock errors*** **-Af0** (page 11-22)

Column c) SV relative frequency bias (GammaN) set in ***Motion - Clock errors*****-Af1** (page 11-22)

Column d) Message frame time = (TOC - half of the ephemeris update interval) + leap seconds

**Line 7**

BROADCAST ORBIT 1

Column a) Satellite Position X (km):

Column b) Satellite Velocity X dot ($km.s^{-1}$) :

Column c) Satellite Acceleration X ($km.s^{-2}$):

Position, Velocity and Acceleration values. Calculated as the SimGEN motion values for the next epoch. (T_next_epoch) defined as: T_next_epoch = TOC - scenario start time.

Column d) Health(Bn): Set in ***Signal control - Upload details*****-Signal health** (page 11-25)

**Line 8**

BROADCAST ORBIT 2

Column a) to Column c) are same as column a) to column c) for broadcast orbit 1

Column d) Frequency number: Set in ***Signal control - General*****-Channel number** (page 11-24)

**Line 9**

BROADCAST ORBIT 3

Column a) to Column c) are same as column a) to column c) for broadcast orbit 1

Column d) Age of operation information(E): 0

**Line 10**

GLONASS Navigation Data Record for second, third and so on satellites.

### 11.8.1.2.2 Example GLONASS Rinex file - version 3.00 format

***Notes****:*

***1)*** *Currently, SimGEN can export data for GPS, GLONASS and Galileo satellites as Rinex version 3.00 format files - see reference jj).*
*For an example of a GPS Rinex file in version 3.00 format, see* ***Example GPS Rinex file - version 3.00 format*** *(page 10-31)*
*For an example of a Galileo Rinex file in version 3.00 format, see* ***Example Galileo Rinex file - version 3.00 format*** *(page 12-10)*

***2)*** *Currently, SimGEN exports Rinex files using "D" to represent the decimal exponent. Reference jj) allows the decimal exponent to be one of "d", "D", "e" or "E"*

This example file listing shows the format of the GLONASS Rinex version 3.00 file (the colour of the text is inverted every fifth line for readability):

```
     3.00           N: NAVIGATION DATA R: GLONASS         RINEX VERSION / TYPE
SimGEN V5.03.00    Spirent             20140820 003000 UTC PGM / RUN BY / DATE
GLUT 1.0000000000D-07 0.000000000D+00    0  0         TIME SYSTEM CORR
  16                                LEAP SECONDS
```


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```
                            END OF HEADER
R02 2014 08 19 23 45 00 5.000000000000D-04 0.000000000000D+00 8.460000000000D+04
   1.219915764609D+04 7.858563142424D-01 0.000000000000D+00 0.000000000000D+00
   7.761267510964D+03 2.769521304887D+00 0.000000000000D+00 1.000000000000D+00
   2.101441553344D+04-1.479151950131D+00 0.000000000000D+00 0.000000000000D+00
R03 2014 08 19 23 45 00 5.000000000000D-04 0.000000000000D+00 8.460000000000D+04
.
.
.
```

Rinex file formatting is critical - Spirent recommends you compare the example file listing above and the description of each line in the listing (given below) with the Rinex file specification in reference jj).

Where relevant, square brackets contain the units.

**Line 1**
Three columns a) to c):
Column a) Rinex version (RINEX VERSION): 3.00

Column b) Rinex Type (TYPE): N: NAVIGATION DATA GLONASS

Column c) Satellite System: R: GLONASS

**Line 2**
Three columns a) to c):
Column a) Name of program creating this file (PGM): SimGEN V5.03.00

Column b) Name of agency creating this file (RUN BY): Spirent

Column c) Date and time of file creation: Scenario start time plus ***General*** (page 11-3)

**Line 3**
(TIME SYSTEM CORR): GLUT GLONASS to UTC time

Four columns a) to d)
Column a) Coefficient a0: TauC set in ***General - System time offset*****-Af0** (page 11-7)

Column b) Coefficient a1(a1) = 0

Column c) Reference time for UTC data(T) = 0

Column d) UTC reference week number(W) = 0

**Line 4**
Delta time due to leap seconds (LEAP SECONDS): as set in **GPS-*General*-General-GPS time leads UTC by** (page 10-6). Set to zero if GPS constellation is not present in the Scenario

***Note**: You must select <**scenario name**>-**Start time**-**UTC offset control-legacy(constellation file)** (page 4-15) before SimGEN can read and write UTC offset, in seconds, to and from Rinex files*

**Line 5**
**(**END OF HEADER)

**Line 6 to Line 9**
These lines contain GLONASS Navigation Data for the first satellite in the constellation. This data occupies four rows by four columns of the file. The satellite SVID precedes the data in the first row. The Rinex file includes data for all satellites present at the start of the scenario.

This example listing identifies the columns of data as a) (first column) to d)(fourth column).

**Line 6**

Column a) PRN: GLONASS Satellite PRN, prefixed with 'R' to specify the GLONASS Constellation. Value should correspond to scenario.

This is followed by:

(EPOCH): TOC (Time of Clock) Defined as the Scenario start time + half of the ephemeris update interval

Column b) SV clock bias (-TauN) set in ***Motion - Clock errors*****-Af0** (page 11-3)

Column c) SV relative frequency bias (GammaN) set in ***Motion - Clock errors*****-Af1** (page 11-22)

Column d) Message frame time = (TOC - half of the ephemeris update interval) + leap seconds

**Line 7**

BROADCAST ORBIT 1

Column a) Satellite Position X (km):

Column b) Satellite Velocity X dot ($km.s^{-1}$) :


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Column c) Satellite Acceleration X (km.s$^{-2}$):

Position, Velocity and Acceleration values. Calculated as the SimGEN motion values for the next epoch. (T_next_epoch) defined as: T_next_epoch = TOC - scenario start time.

Column d) Health(Bn):set in ***Signal control - Upload details*-Signal health** (page 11-25)

**Line 8**

BROADCAST ORBIT 2

Column a) to Column c) are same as column a) to column c) for broadcast orbit 1

Column d) Frequency number: set in ***Signal control - General*-Channel number** (page 11-24)

**Line 9**

BROADCAST ORBIT 3

Column a) to Column c) are same as column a) to column c) for broadcast orbit 1

Column d) Age of operation information(E): 0

**Line 10 onwards**

GLONASS Navigation Data Record for second, third and so on satellites.

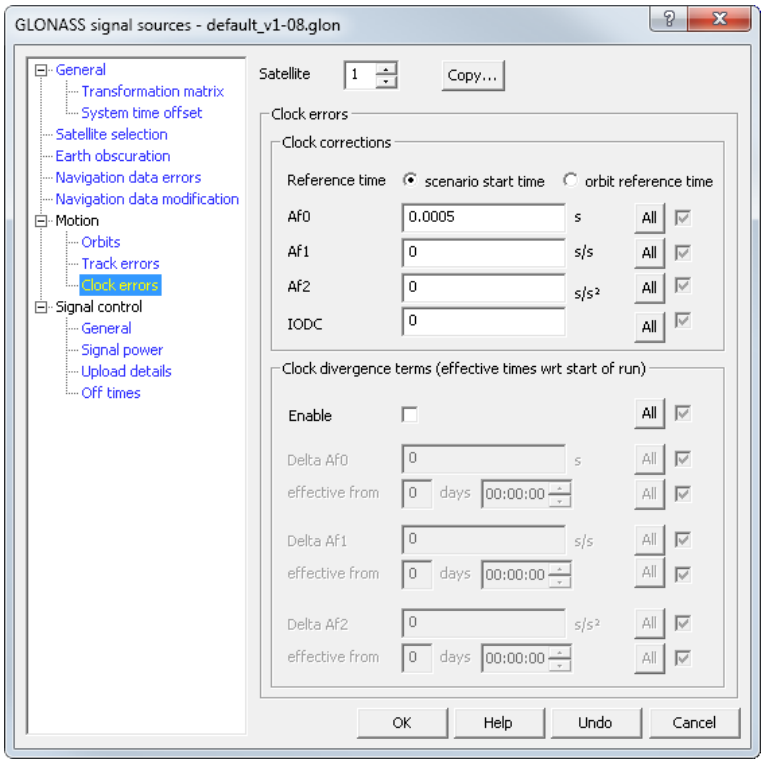
## 11.8.2 Motion - Track errors

This parameter is the same as **GPS-*Motion - Track errors*** (page 10-35).

## 11.8.3 Motion - Clock errors

***Note**: Setting the **Delta Af0** divergence term is equivalent to applying a pseudorange error to that satellite.*

Use this dialog to specify clock corrections and clock divergence.




**Clock corrections**

Transmitted in the Navigation Data message and describe the drift of the GLONASS satellite's clock over time. SimGEN models clock corrections in the RF signal and transmits the clock corrections in the Nav Data message.

These terms are identical to the GPS parameters **Af0**, **Af1** and **Af2**, see **GPS-*Motion - Clock errors*** (page 10-37), except they define the bias, rate and bias rate acceleration of the GLONASS satellite clocks from the Russian time standard UTC(SU).

Clock bias information is referenced to the start of the scenario.

Each satellite transmits these values in its Navigation message.


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**Clock divergence**

Added to the RF signal ONLY, so they simulate the satellite's clock drift as being different from that described in the Nav Data message (unless set to 0). These terms are analogous to GPS parameters **Af0**, **Af1** and **Af2**, but apply only to the signal timing. SimGEN does not correct **Clock divergence** terms in the navigation data. **Clock divergence** terms can simulate errors in signal timing and Spirent considers them clock or range errors.

To use **Clock divergence** terms select **Clock divergence terms-Enable**.

| | | | |
|---|---|---|---|
| **Clock errors** | Reference a) specifies the clock correction terms, which SimGEN transmits in the navigation data. They modify the timing of the simulated signals accordingly. The reference time for these parameters is the start of the simulation. The modified parameters transmitted in the navigation data allow for the difference between the simulation start time and t*oc*/ t*oe*. Spirent uses the clock correction equation given in reference a) to modify the signal timing. | | |
| **Reference time** | Up to SimGEN 2-90, SimGEN applied clock error coefficients relative to the scenario start time, instead of using the orbital data reference time. Changing the scenario start time could result in large (over-ranging) clock terms, which are not ideal if you want to, for example, duplicate Yuma almanac data, or run two tests with a small difference in start time and see continuity in the clock effects.<br>Choose from: | | |
| | **scenario start time** (default): references clock correction terms to the scenario start time (giving backwards compatibility)<br>**orbit reference time**: references clock correction terms to the orbital reference time | | |
| **Af0** (Zero-order term) | Units: seconds | Range:<br>±0.9765 E-3 s | Default:<br>5.0 E-4 |
| **Af1** (First-order term) | Units: seconds per second | Range:<br>±9.313 E-10 $s.s^{-1}$ | Default: 0 |
| **Af2** (Second-order term) | Units: seconds<br>per $(second)^2$ | Range:<br>±3.525 E-15 $s.s^{-2}$ | Default: 0 |
| **IODC** | Sets initial value of IODC at start of scenario for **Satellite**.<br>IODE has the same start value as IODC.<br>SimGEN increments IODC and IODE with each successive upload. | | |
| **Clock divergence terms** | | | |
| **Delta Af0** (Zero-order term) | Units: seconds | Range:<br>±25.0 E-3 s | Default: 0 |
| ***Note**: The start time for **Delta Af0** is fixed at 0 days 00:00:00 (start of run)* | | | |
| **Delta Af1** (First-order term) | Units: seconds per second | Range:<br>±1.0 E-5 $s.s^{-1}$ | Default: 0 |
| ***Note**: Set the start time for **Delta Af1** using **Effective from*** | | | |
| **Delta Af2** (Second-order term) | Units seconds<br>per $(second)^2$ | Range:<br>±1.0 E-12 $s.s^{-2}$ | Default: 0 |
| ***Note**: Set the start time for **Delta Af2** using **Effective from*** | | | |
| **Effective from** | Sets the start time for **Delta Af1** and **Delta Af2** | | |
| | Units: d hh:mm:ss | Range:<br>0 days 00:00:00<br>to 23 days 23:59:59 | Default: 0 days 00:00:00<br>(start of run) |

## 11.9 Signal control

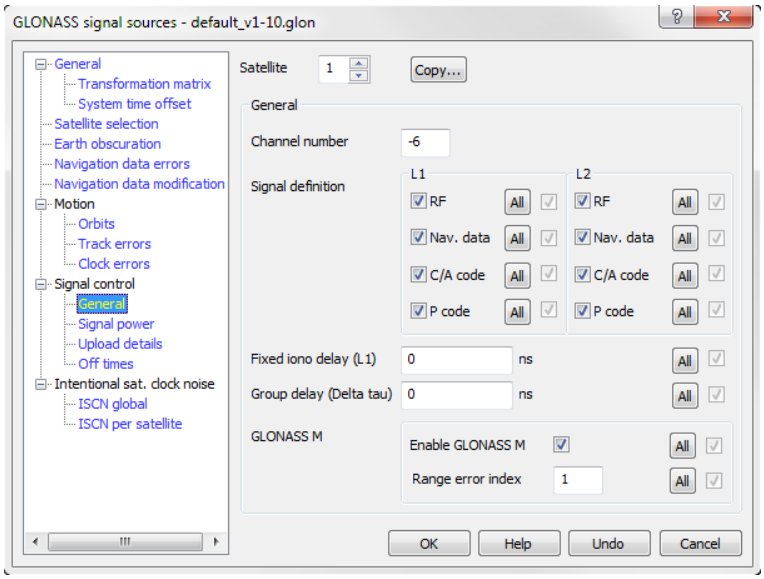
Use these dialogs to specify RF characteristics of the GLONASS signal.


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## 11.9.1 Signal control - General

***Note**: SimGEN version 5.07 onward selects by default **Signal definition-Pcode** for both L1 and L2*

Use this dialog, to specify general characteristics of the GLONASS signal.




Click **All** to apply the value of the parameter (or apply the action) to all GLONASS satellites

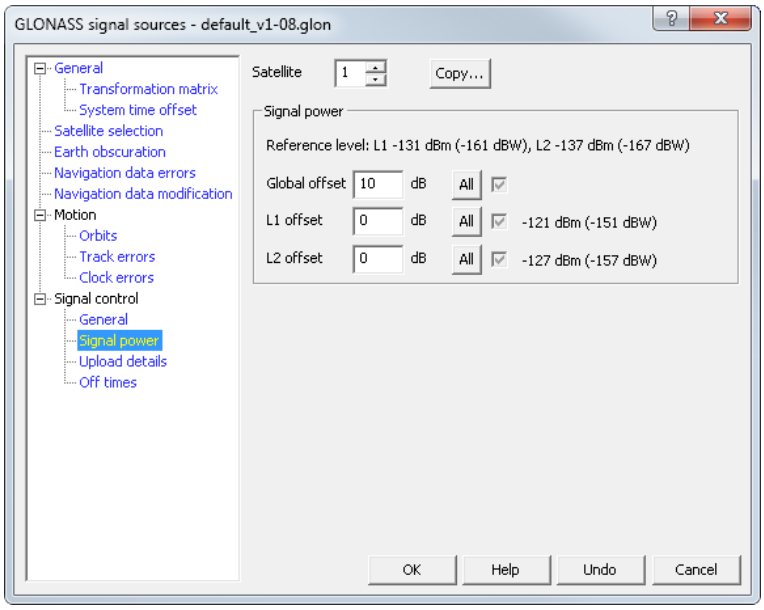
| | | | |
|---|---|---|---|
| **Satellite** | Select the **Satellite** whose settings you want to change.<br>Click **Copy** to copy these **Signal control-General** parameters to the Satellites you select in the dialog. | | |
| **Channel number** | Type the GLONASS frequency channel number allocated to Satellite. | | |
| | Units: none | Range: -7 to 24, but see Note 5) at the start of this Chapter | Default: 1 |
| **Signal definition - L1, L2** | Select / deselect for each frequency L1 and L2: | | |
| | Defaults for both **L1** and **L2**<br>Selected (on): **RF**, **Nav data, C/A code** and **P-code** | | |
| ***Note**: When using GLONASS P-code, SimGEN generates P-code at the same power level as C/A code, but displays only the C/A code RF power level. The total RF power level of a simulated GLONASS satellite using both C/A code and P-code is 3 dB higher than the power level SimGEN shows.* | | | |
| **Fixed iono delay (L1)** | Type the delay you want to apply for Satellite | | |
| | Units: nanoseconds | Range: 0 to 500 ns | Default: 0 |
| **Group delay (Delta tau)** | Type the group delay you want to use for Satellite | | |
| | Units: nanoseconds | Range: -14.9 to 14 ns | Default: 0 |
| **Enable GLONASS M** | Select (default): Generates GLONASS M-type Navigation data.<br>Enables **Range error index**<br>Deselect: Do not generate GLONASS M-type Navigation data. | | |
| **Range error index** | Defines the user range accuracy broadcast in the navigation data by the GLONASS-M nav data word FT, see Table 4.4 of reference e) | | |
| | Units: none | Range: 0 to 15 | Default: 1 |


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## 11.9.2 Signal control - Signal power

***Note***: *If you set antenna patterns using* ***Receive and transmit antennas*** *(page 23-1) and include negative figures (in other words, gain) there is a possibility the sum of the RF power level you specify in the constellation file and the antenna gain will exceed the maximum power capability of your signal generator. If this occurs during a scenario, the power level will limit at the maximum capability of the signal generator. These limits are:*
*+20 dB for GSS7xxx and GSS8000-series signal generators*
*+15 dB for the GSS6700 (and the superseded GSS6560) signal generator*

Use this dialog to control the signal-level characteristics of all simulated carrier frequencies at the RF output of the signal generator.




If you select ***General*****-Signal Strength-Modelled** (page 11-3), SimGEN applies the values you enter in this dialog before performing modelling.

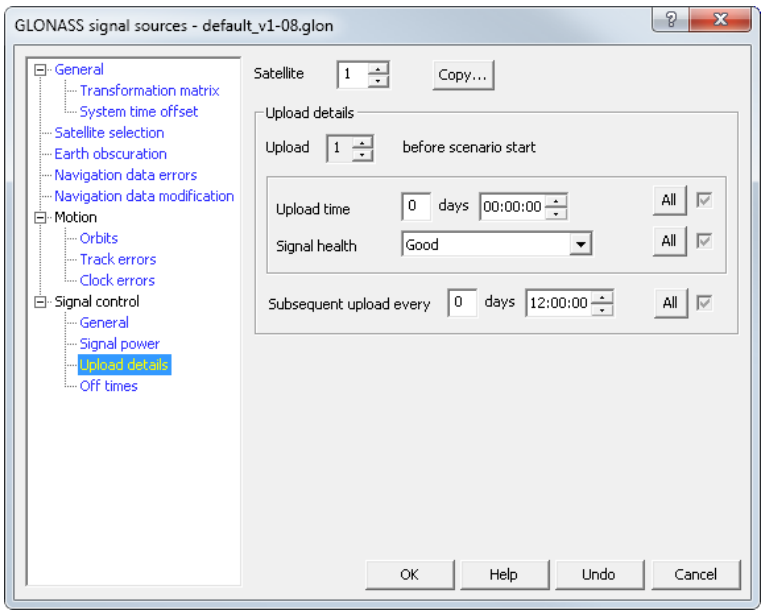
Click **All** to apply the value of the parameter (or apply the action) to all GLONASS satellites

| | | | |
|---|---|---|---|
| **Satellite** | Select the **Satellite** whose settings you want to change.<br>Click **Copy** to copy these parameters to the Satellites you select in the dialog. | | |
| **Signal power** | Set the **Global offset** from the GLONASS L1 and L2 reference levels.<br>Set the individual **L1 offset** and **L2 offset** levels | | |
| ***Note****: SimGEN shows the C/A code power level to the right of* ***All****. A simulated GLONASS satellite using both C/A code and P-code has an RF power level 3 dB higher than this power level (see Note below).* | | | |
| **Global offset,**<br>**L1 offset,**<br>**L2 offset** | Units: decibels | Range: - 20.0<br>to 20.0 dB | Default: 10 (**Global**),<br>0 (**L1** and **L2**) |
| ***Note****: When you enable GLONASS P-code, SimGEN generates P-code at the same power level as C/A code, but displays only the C/A code RF power level. The total RF power level of a simulated GLONASS satellite using both C/A code and P-code is 3 dB higher than the power level SimGEN shows.* | | | |

## 11.9.3 Signal control - Upload details

Use this dialog specify the times when the ground control station uploads new data to the GLONASS satellite.


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There are two upload times:

- The time of **Upload 1** must be on or before the scenario start time.
- The time of **Upload 2** must be after the scenario start time.

The Navigation data message at the scenario start time will reflect **Upload 1** time. Specifying a time greater than 14 days before the scenario start-time will result in the satellite declared unhealthy.

| | | |
|---|---|---|
| **Satellite** | Select the **Satellite** whose settings you want to change.<br>Click **Copy** to copy these parameters to the Satellites you select in the dialog. | |
| **Upload time for Upload 1** | For the Default time, the upload is at the scenario start time. | |
| | Units: days hh:mm:ss | Default: 0 days 00:00:00 |
| **Upload time for Upload 2** | If zero, no second upload will occur during the scenario. | |
| | Units: days hh:mm:ss | Default: 0 days 12:00:00 |
| **Signal health** | Set for both **Upload 1** and **Upload 2**<br>Choose from Good (default) or Bad | |
| **Subsequent upload every** | Specifies the interval (after Upload 2) at which further uploads take place, using the data values you specify for Upload 2.<br>This is necessary for very long scenarios where the absence of an upload would result in the satellite health declared bad. | |
| | Units: days hh:mm:ss | Default: 0 days 00:00:00 |

## 11.9.4 Signal control - Off times

This is the same as **GPS-*Signal Control - Off times*** (page 10-50)


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# 12 Galileo Open Service constellation editor

***Notes**:*

***1)** SimGEN determines the E5 frequency and passes this data to the signal generator*

***2)** The signal generator, not SimGEN, applies offsets to create the E5a and E5b frequencies*

***3)** All software truth data is based on the E5 band centre frequency*

***4)** The Galileo OS ICD, reference w), is an unrestricted sub-set of the full Galileo ICD, reference r). Where this user manual refers to the full Galileo ICD, Spirent implies compliance to the Galileo OS ICD*

This table gives the Galileo signal structure, with the table below giving the Galileo E1, E5 and E6 power reference levels.

| Galileo Signal | Power reference level, dBm |
|---|---|
| E1-A | -125.5 |
| E1-B and E1-C | -128.5 |
| E5a and E5b | -128.5 |
| E6-A | -125.5 |
| E6-B and E6-C | -128.5 |

Reference r) gives the full Galileo SIS ICD; reference w) gives the Galileo OS ICD.

SimGEN version 2-83 SR02 onwards supports Galileo Open Service for GSS8000-series signal generators when using signal generator card firmware version 2-12 (or later) and FPGA image release 25 (or later).

SimGEN version 2-83 SR02 onwards supports Galileo Open Service for GSS7800 signal generators when using signal generator card firmware version 1-31 (or later) and FPGA image release 25 (or later).

To find the firmware version and FPGA image of your signal generator cards and then determine if your signal generator needs upgrading, Spirent recommends you follow this procedure:

- → Read the section on the menu item **Options-*Hardware Configuration*** (page 5-18), then display your signal generator configuration
- → Select your signal generator
- → Click **Output details…**
- → Contact Spirent Global Services and provide the relevant details from the configuration window.
- → Spirent Global Services will then determine if your signal generator needs upgrading and provide details on the upgrade procedure.

The Galileo constellation editor is similar to the ***GPS constellation editor*** (page 10-1). If this Chapter on the Galileo constellation editor does not give details for a scenario parameter, see the details for the parameter with the same name in the ***GPS constellation editor***.

The **Galileo constellation-Galileo signal sources file** characterises the Galileo satellites in a simulation. This file is often known as the “Galileo Constellation file”, and is one of the source files defining a scenario. The default signal sources filename for the Galileo constellation file is *default_vx-yy.gleo*.

To use the Galileo constellation, first see **Receive and transmit antennas-*Associate a GNSS signal with an antenna*** (page 23-4) and associate the appropriate signal with the antenna(s) you want to use.

## 12.1 Galileo constellation editor

***Note**: SimGEN’s range of acceptable values may be different from the values commonly used in satellite navigation systems.*

Use the constellation editor to edit data in the Galileo constellation file. The editor shows the data in the Galileo constellation file as a series of “pages”. The left-hand area shows the pages you can select for editing, the right-

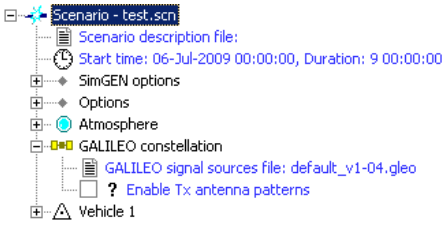

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hand area shows the details of the page you selected in the left-hand area. This section describes how you select and change details in the right-hand area.

As a Galileo Open Service user, some parameters may be set to a fixed value, or disabled.

SimGEN checks the range of the value you type in a text box and, if incorrect, displays the range of acceptable values.

After associating the Galileo signal type with an antenna, the Galileo constellation file appears in the **Scenario contents** window:



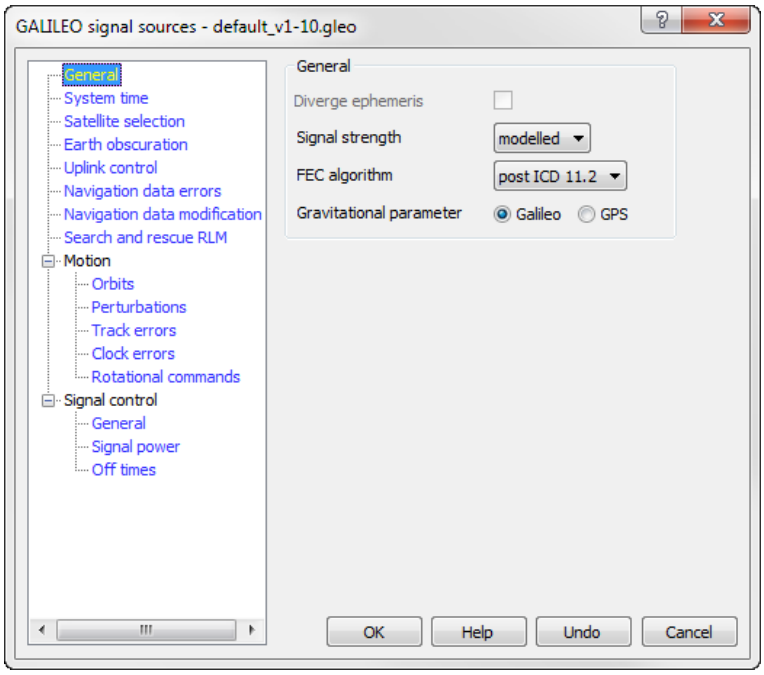

**Receive and transmit antennas-*Transmitter antenna level and phase*** patterns (page 23-20) details creating and applying **Tx antenna patterns**.

Edit the Galileo constellation file in the same way as you would edit a GPS constellation file. First, expand **Galileo constellation**. Then:

→ Select **Galileo constellation-Signal sources file**

→ Right-click and select **Edit**

→ You will see the **Signal sources-General** dialog, shown below. The Galileo signal sources file has the default name, *default_vx-yy.gleo*.




The left-hand area of the **Signal sources** dialog shows the titles of all “pages” you can edit in the file. Click on a title to edit it.

After editing the **Signal sources file**, click **OK** then save the file to a name of your choice using the dialog. Select **Shared** to save this file to the shared folder, so making it available to other scenarios.


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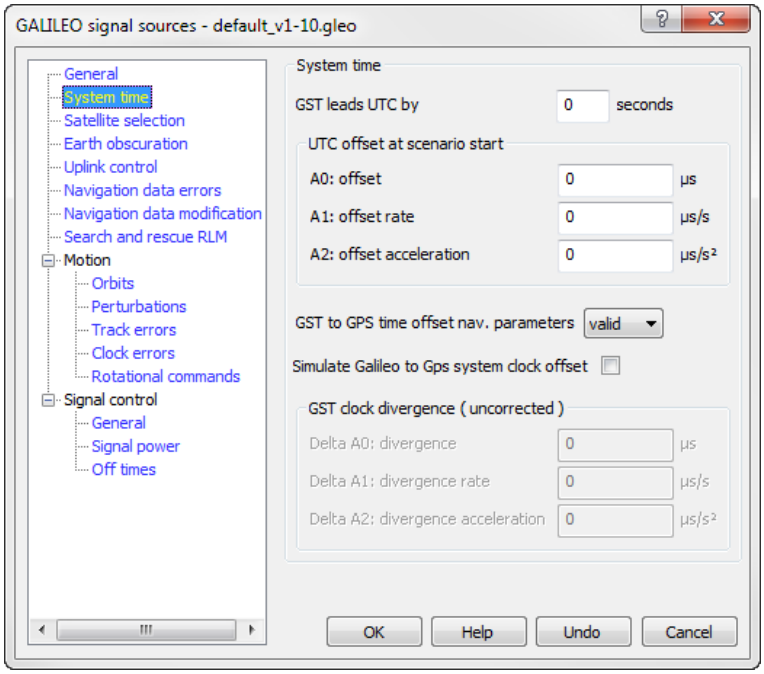
## 12.2 General

Use this dialog, see above, to edit the parameters affecting all Galileo satellites.

| | |
|---|---|
| **Diverge ephemeris** | Disabled - currently not available in SimGEN |
| **Signal strength** | Select whether SimGEN modifies satellite signal-levels based on satellite-to-antenna distance or uses a fixed signal level. **GPS-*General - Modelled and fixed signal strength*** (page 10-8) gives further details on **Modelled** and **Fixed**. In each case, first set the base RF power level using ***Signal control - Signal power*** (page 10-46)<br><br>Choose from: |
| **Modelled** | (default) SimGEN modifies satellite signal level as a function of the satellite to receiver antenna distance in proportion to $(distance)^{-2}$ |
| **Fixed** | SimGEN does not modify the signal level as a function of satellite to receiver antenna distance. |
| **FEC algorithm** | ***Note**: This refers to the full Galileo ICD. Open Service users should always use the default selection.*<br>Choose from (default) **post ICD 11.2** or **to ICD 11.2** |
| **Gravitational parameter** | Choose the Gravitational parameter SimGEN uses for Galileo satellite orbits.<br>Galileo (default)<br>GPS - Select to allow comparison with GPS satellites. |
| ***Note**: The Galileo gravitational parameter - see reference r), is different to the GPS gravitational parameter - see reference b).* | |

## 12.3 System time

The Galileo navigation message broadcasts the Galileo System Time (GST) offset parameters (A0 and A1) with respect to UTC (GPS time):




SimGEN also uses the coefficient A2 (not broadcast) to represent the offset acceleration. SimGEN uses coefficient A2 to propagate the broadcast values to the relevant times.

| | | | |
|---|---|---|---|
| **GST leads UTC by** | Disabled unless you select <**scenario name**>-***Start time***-**UTC offset control-Legacy (constellation file)** (page 5-33) to give compatibility with scenarios created up to SimGEN version 2-90. When enabled, you can specify the lead of GST over UTC (Universal Time Co-ordinated) as an integer number of seconds. | | |
| | Units: seconds | Range: -128 to +127 s | Default: |


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| | | | |
|---|---|---|---|
| **UTC offset at scenario start** | Enter the UTC offset parameters at the scenario start time. This determines the offset of Galileo system time with respect to UTC, in addition to any leap seconds. The update times for the broadcast UTC data will correspond with the almanac update times, but changes are restricted by the resolution of the reference time ($t_{ot}$) for this data (3 600 seconds). This means this information will only change on the hourly epoch that is at, or immediately prior to, the almanac update time. | | |
| **A0: offset**<br>**Delta A0: divergence** | Units: microsecond | Range: ±100 μs | Default: 0 |
| **A1: offset rate**<br>**Delta A1: divergence rate** | Units: microsecond per second | Range: ±0.0074 $\mu s.s^{-1}$ | Default: 0 |
| **A2: offset acceleration** | Units: microsecond per $(second)^2$ | Range: -2.17E-13 to +2.13E-13 $\mu s.s^{-2}$ | Default: 0 |
| **Delta A2: divergence acceleration** | Units: microsecond per $(second)^2$ | Range: -1E-6 to +1E-6 $\mu s.s^{-2}$ | Default: 0 |
| **GST to GPS time offset nav. parameters** | Select from **valid** (default) or **invalid** | | |
| ***Note**: Selecting invalid sets all the relevant Navigation Data fields to "all ones"* | | | |
| **Simulate Galileo to Gps system clock offset** | You cannot directly specify the GST offset with respect to GPS, it is determined from the difference between the current UTC offset for GST and that for GPS. Choose from:<br>**Not selected** (default): SimGEN does not simulate clock offsets<br>**Selected**: specify the broadcast parameters ($A_{0G}$ and $A_{1G}$) SimGEN will use to offset the Galileo RF signals with respect to the GPS RF signals. The pseudorange data that SimGEN logs for Galileo satellites will include a common offset representing this effect.<br>The reference time ($t_{oG}$) is defined as for $t_{ot}$<br>Enables **Delta A0: divergence**, Delta A1: divergence rate and Delta A2: divergence acceleration | | |
| ***Note**: SimGEN sets the GPS to UTC offset to zero if the scenario does not use GPS.* | | | |
| **GST clock divergence (uncorrected)**<br>(see **A0**, **A1** and **A2** parameter details above) | Divergence terms can apply an error in the GST model. These terms represent an offset in GST with respect to the broadcast coefficients.<br>If the divergence terms are non-zero, and your scenario is simulating the effect of the GST to GPS offset, there will be a common offset in the simulated pseudorange for all Galileo satellites. This is included in logged pseudorange error data.<br>The divergence error propagates throughout the run.<br>The divergence parameters are detailed above | | |
| ***Note**: At the update time, the GST parameters are not compensated for this propagation* | | | |

## 12.4 Satellite selection

This dialog is the same as **GPS-*Satellite selection*** (page 10-10).

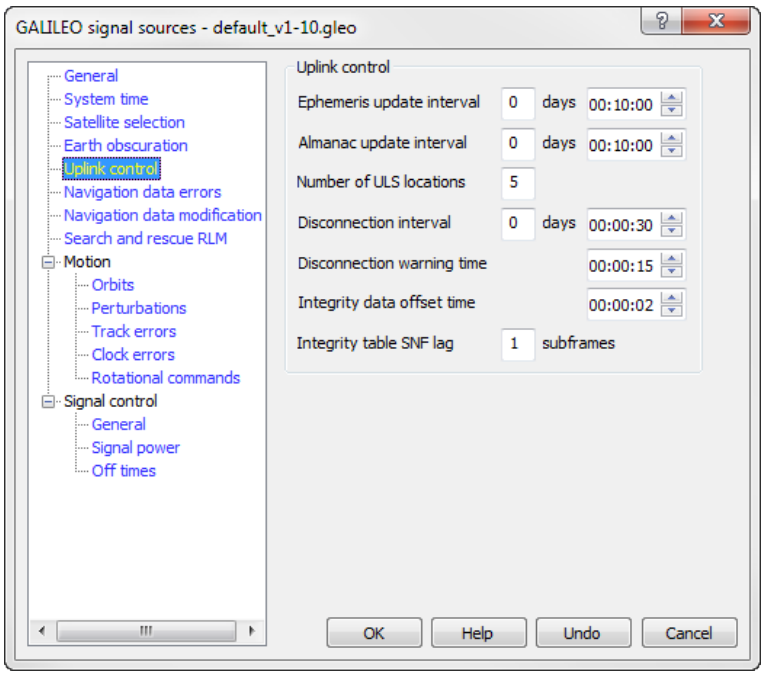
## 12.5 Earth obscuration

Use this dialog to determine how SimGEN calculates Galileo satellite obscuration by the Earth's surface, it is the same dialog as in **GPS-*Earth obscuration*** (page 10-11).

## 12.6 Uplink control

Sets the Almanac and Ephemeris update intervals in the broadcast navigation data for all Galileo satellites:


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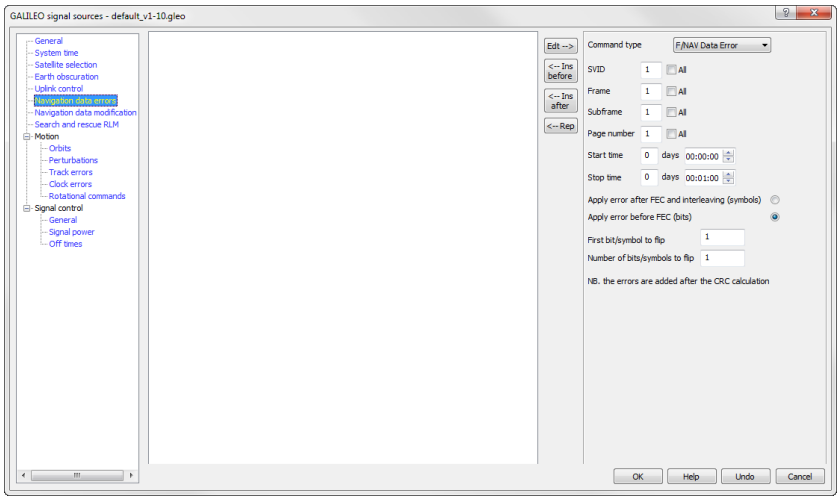



| | | | |
|---|---|---|---|
| **Ephemeris update interval,**<br>**Almanac update interval** | Units:<br>d hh:mm:ss | Range:<br>0 days 00:10:00<br>to 23 days 23:59:59<br>in 00:10:00 steps | Default: 00:10:00 |
| **Number of ULS locations** | Specify the number of ULS (Up Link Station) locations to use. SimGEN uses ULS locations that are regularly spaced around the equator. During a scenario, SimGEN allocates a ULS to each Galileo satellite according to its current longitude. When SimGEN switches between ULS locations, it automatically disconnects the SAR return link, see<br>***Search*** and rescue RLM (page 12-9). | | |
| | Units: none | Range: 1 to 9 | Default: 5 |
| ***Note**: Range = 1 ensures there is no disconnection of the SAR return link.* | | | |
| **Disconnection interval** | Specify the time you want SimGEN to wait after disconnecting from the ULS before re-establishing the SAR return link with a new ULS. | | |
| | Units:<br>d hh:mm:ss | Range:<br>0 days 00:00:00<br>to 23 days 23:59:59 | Default: 00:00:30 |
| **Disconnection warning time** | Specify the disconnection warning status in the Galileo navigation data.<br>The disconnection warning time you enter is the time (in advance) before SimGEN disconnects from a ULS. | | |
| | Units: hh:mm:ss | Range: 00:00:00<br>to 00:00:30 | Default: 00:00:15 |
| **Integrity data offset time** | Specify the offset of the TOC value for the broadcast integrity data to the start time of transmission of this data.<br>Enter the time before starting transmission of the integrity data | | |
| | Units: hh:mm:ss | Range: 00:00:01<br>to 00:00:06 | Default: 00:00:02 |
| **Integrity table SNF lag** | Specifies the delay (in terms of the number of subframe intervals for I/NAV and G/NAV) in updating the SNF index in the broadcast navigation integrity data after cutover to a new ephemeris set. | | |
| | Units: Subframes | Subframes: 0 to 2 | Default: 1 |

# 12.7 Navigation data errors

***Note**: To see the Help file topic on Navigation data errors for this constellation, Spirent recommend you select the Help topic from the **SimGEN Help-Contents** tab; clicking **Help** or pressing F1 on your keyboard may display an invalid Help topic.*

Use the SimGEN ***List Editor*** (page 5-33) to insert Navigation data errors:




First, select the **Command type**. Then select the specific **Command type**. The section ***Navigation data errors - common parameters*** describes parameters common to each **Command type** and this table details the sections describing the parameters for the specific **Command type**:

| Command type |
|---|
| ***F/NAV Data Error*** (default) |
| ***I/NAV Data Error for both E1-B and E5b*** |

## 12.7.1 Navigation data errors - common parameters

Selecting **All** applies that parameter setting to all SVIDs. For example selecting **SVID-All** applies the **Command type** to all SVIDs.

These parameters are common for all **Navigation data errors-Command types**:

| | | | |
|---|---|---|---|
| **SVID** | Type the SVID you want to use or select **All** | | |
| **Start time**<br>**Stop time** | Units:<br>d hh:mm:ss | Range:<br>0 days 00:00:00<br>to 23 days 23:59:59 | **Start** default:<br>0 days 00:00:00 (start of run)<br>**Stop** default:<br>0 days 00:01:00 |
| ***Note**: Always set Stop time to be later than Start time* | | | |
| **Apply error after FEC and interleaving (symbols)** | (default) Select to apply the error after SimGEN generates the symbol stream | | |
| **Apply error before FEC** | Select to apply the error before SimGEN generates the symbol stream - the CRC is invalid | | |
| ***Notes:***<br>***1)** If you dump the navigation data (using **Options-General Options-Dump navigation data**), you can check any errors applied before the FEC using **SimGEN utilities-**Galileo Nav Data Extract (page 26-33) utility*<br>***2)** Changes made at the symbol level do not affect the dumped navigation data and you cannot check these errors using **SimGEN utilities-**Galileo Nav Data Extract (page 26-33) utility* | | | |

## 12.7.2 F/NAV Data Error

Selecting **All** applies that parameter setting to all SVIDs. For example selecting **SVID-All** applies the **Command type** to all SVIDs.


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These parameters are specific for **F/NAV Date Errors**:

| | | | |
|---|---|---|---|
| **Frame** | Units: none | Range: 1 to 2 | Default: 1 |
| ***Note**: The Galileo SIS ICD, reference r), does not define a frame numbering system. However, two full frames are necessary to transmit a full almanac set.*<br>*Spirent assumes Frame 1 starts on any 1 200 s epoch in GST.* | | | |
| **Subframe** | Units: none | Range: 1 to 12 | Default: 1 |
| **Page number** | Units: none | Range: 1 to 5 | Default: 1 |
| ***Note**: This is the Page number within the Subframe and not the page type.*<br>*Page number 5 relates to page type 5 or 6, determined by the Subframe number.*<br>*An odd numbered Subframe contains a type 5 page.*<br>*An even numbered Subframe contains a type 6 page.* | | | |
| **First bit to flip** | This depends when you apply the error:<br>Error after FEC: Type the first symbol of the 500 broadcast symbols to invert (flip)<br>Error before FEC: Type the first bit of the 244-bit message to invert (flip) | | |
| **Number of bits to flip** | Type the number of bits (or symbols) in the message to invert (flip) | | |

### 12.7.3 I/NAV Data Error for both E1-B and E5b

Selecting **All** applies that parameter setting to all SVIDs. For example selecting **SVID-All** applies the **Command type** to all SVIDs.

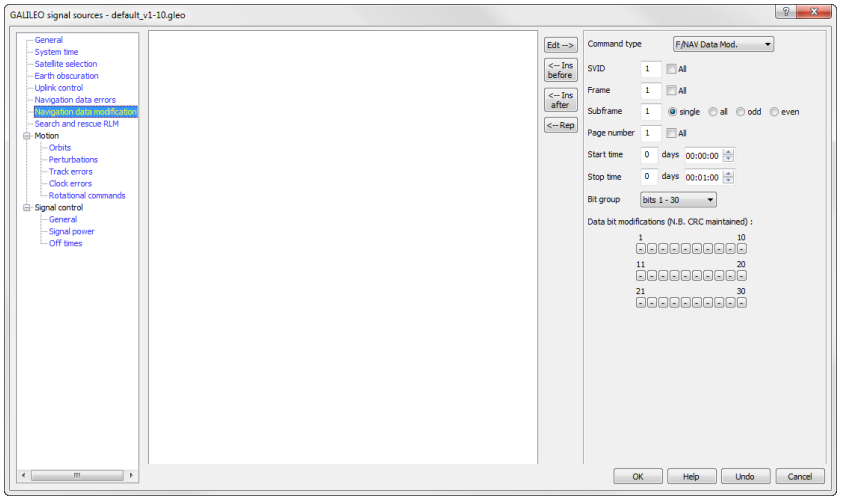
These parameters are specific for **I/NAV Data Errors**, for both E1-B and E5b:

| | | | |
|---|---|---|---|
| **Subframe** | Units: none | Range: 1 to 24 | Default: 1 |
| **Page time (s)** | Units: none | Range: 0 to 29 | Default: 0 |
| **First bit to flip** | This depends when you apply the error:<br>Error after FEC: Type the first symbol of the 250 broadcast symbols to invert (flip)<br>Error before FEC: Type the first bit of the 120-bit message to invert (flip) | | |
| **Number of bits to flip** | Type the number of bits (or symbols) in the message to invert (flip) | | |

## 12.8 Navigation data modification

***Note**: To see the Help file topic on Navigation data modifications for this constellation, Spirent recommend you select the Help topic from the **SimGEN Help-Contents** tab; clicking **Help** or pressing F1 on your keyboard may display an invalid Help topic.*

Use the SimGEN ***List Editor*** (page 5-33) to create Navigation data modifications. This figure shows the Navigation data modification editor:





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First, select the **Command type**. Then select the specific **Command type**. The section ***Nav data modification - common parameters*** describes parameters common to each **Command type** and this table details the sections describing the parameters for the specific **Command type**:

| Command type |
|---|
| ***F/NAV Data Modification*** (default) |
| ***Data modification for both E1-B and E5b*** |

## 12.8.1 Nav data modification - common parameters

Selecting **All** applies that parameter setting to all SVIDs. For example selecting **SVID-All** applies the **Command type** to all SVIDs. These parameters are common for all **Navigation data modification-Command types**:

| | | | |
|---|---|---|---|
| **SVID** | Type the SVID for which you want to modify the Navigation data | | |
| **Start time**<br>**Stop time** | Units:<br>d hh:mm:ss | Range:<br>0 days 00:00:00<br>to 23 days 23:59:59 | **Start** default:<br>0 days 00:00:00 (start of run)<br>**Stop** default:<br>0 days 00:01:00 |
| ***Note**: Stop time must always be later than Start time* | | | |

## 12.8.2 F/NAV Data Modification

Selecting **All** applies that parameter setting to all SVIDs. For example selecting **SVID-All** applies the **Command type** to all SVIDs.

These parameters are specific for **F/NAV Data Modification**:

| | | | |
|---|---|---|---|
| **Frame** | Units: none | Range: 1 to 2 | Default: 1 |
| ***Note**: The Galileo SIS ICD, reference r), does not define a frame numbering system. However, two full frames are necessary to transmit a full almanac set.*<br>*Spirent assumes Frame 1 starts on any 1 200 s epoch in GST.* | | | |
| **Subframe** | Units: none | Range: 1 to 12 | Default: 1 |
| Select one of:<br>**single**<br>**all**<br>**odd**<br>**even** | (default) uses the Subframe value entered<br>uses the range of Subframe values<br>uses all odd Subframe values<br>uses all even Subframe values | | |
| **Page number** | Units: none | Range: 1 to 5 | Default: 1 |
| ***Note**: This is the Page number within the Subframe and not the page type.*<br>*Page number 5 relates to page type 5 or 6, determined by the Subframe number.*<br>*An odd numbered Subframe contains a type 5 page.*<br>*An even numbered Subframe contains a type 6 page.* | | | |
| **Bit group** | Choose from: bits **1- 30** (default) to bits **211-214**<br>Select the **Data bit modifications** you want to use for the **Bit group** you select.<br>Click on the button for the bit you want to modify.<br>This table (page 10-16) details the symbols on each button. | | |
| ***Note**: You cannot specify any modification of the CRC data (bits 215 to 238) here. SimGEN correctly determines CRC data after application of the Navigation data modification command*<br>***Navigation data errors*** *(page 12-6) details applying errors in the CRC.*<br>*Tail bits will always default to all zeroes, you can corrupt tail bits by applying an error to the relevant bits.* | | | |

### 12.8.2.1 Data modification for both E1-B and E5b

Selecting **All** applies that parameter setting to all SVIDs. For example selecting **SVID-All** applies the **Command type** to all SVIDs.

These parameters are specific for **I/NAV Data modification** for both E1-B and E5b:

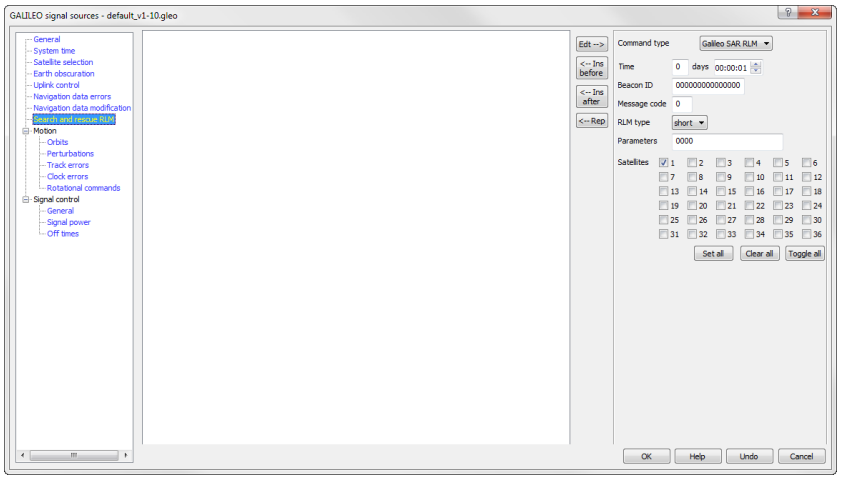
| | | | |
|---|---|---|---|
| **Subframe** | Units: none | Range: 1 to 24 | Default: 1 |


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| | | | |
|---|---|---|---|
| **Page time (s)** | Units: none | Range: 0 to 29 | Default: 0 |
| Select one of:<br>single<br>odd<br>**even** | (default) uses the Subframe value entered<br>uses all odd Subframe values<br>uses all even Subframe values | | |
| ***Notes:***<br>***1)*** *The Galileo SIS ICD does not define a numbering system for the 30 pages within a sub-fame (one page per second). It only designates pages as "Odd (0)" or "Even (1)". Spirent identifies these pages in terms of their page time within the subframe for each signal.*<br>***2)*** *The first page in each subframe has a page time of zero and is always an "Even" page for both E5b (word type 1) and E1-B (word type 2). For both signals, an even page time relates to an "Even" page type.* | | | |
| **Bit group** | Choose from: **bits 1- 30** (default) to **bits 91-114**<br>Select the **Data bit modifications** you want to use for the **Bit group** selected.<br>Click on the button for the bit you want to modify.<br>This table (page 10-16) details the symbols on each button. | | |
| ***Note****: You cannot make changes to the CRC value (Odd pages - bits 83-106) and Tail bits (115-120). After applying the modification, the CRC is correctly determined.*<br>***Navigation data errors*** *(page 12-6) details applying errors in the CRC.* | | | |

## 12.9 Search and rescue RLM

The Search and Rescue (SAR) return link provides the capability to send return link messages (RLM) to a beacon equipped with a suitable receiver. Use the SimGEN ***List Editor*** (page 5-33) to create Search and Rescue RLM:




This table shows the RLM types.

| RLM type | Description |
|---|---|
| **Long** | Three long RLM of 160 bits every 60 seconds.<br>One long RLM takes sixteen seconds (eight pages) to transmit |
| **Short** | Seven short RLM of 80 bits every 60 seconds.<br>One short RLM takes eight seconds (four pages) to transmit. |

SimGEN sends this SAR data on the E1-B channel, it replaces the usual dummy SAR data when scheduled for a particular satellite at a particular time.

| | | | |
|---|---|---|---|
| **Time** | Units:<br>d hh:mm:ss | Range:<br>0 days 00:00:01<br>to 23 days 23:59:59<br>(in two second steps) | Default:<br>0 days 00:00:01 |
| **Beacon ID** | Specify the beacon ID to determine whether the received RLM is addressed to itself | | |


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| | | |
|---|---|---|
| | Range: 60 bits as a string of fifteen hexadecimal characters.<br>The first data bit corresponds with the most significant bit of the first character. | Default: 000000000000000 |
| **Message code** | Range: 0 to 15 ( decimal number) | Default: 0 |
| RLM type | Return Link Message type. Select from: **short** or **long** | |
| **Parameters for RLM type-short** | (default) Range: 16 bits as a string of four hexadecimal characters.<br>The first data bit corresponds with the most significant bit of the first character. | Default: 0000 |
| **Parameters for RLM type-long** | Range: 96 bits as a string of 24 hexadecimal characters.<br>The first data bit corresponds with the most significant bit of the first character. | Default: 0000 |
| **Satellites** | Select the satellite(s) that broadcast the RLM.<br>Use the buttons **Set all**, **Clear all** and **Toggle all**, as appropriate | |

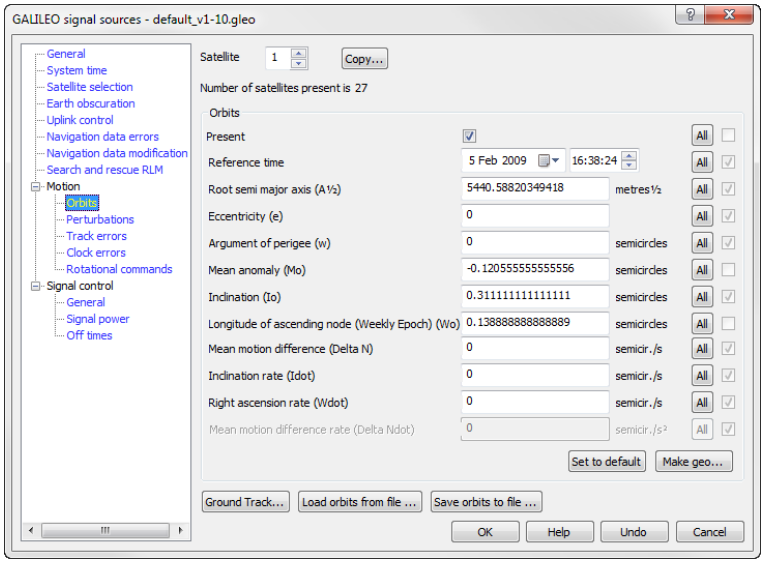
## 12.10 Motion

The motion pages detail the satellite orbits and errors.

### 12.10.1 Motion - Orbits

***Note**: You can download Galileo Almanac data from:* www.gsc-europa.eu/system-status/almanac-data

This dialog is the same as **GPS-*Motion - Orbits*** (page 10-21), although the Galileo system does not use **Mean motion difference rate (Delta Ndot)**. The default data in each page of the dialog describes the “standard” Galileo constellation see reference r):




The buttons in the **Motion-Orbits** dialog are identical to those for GPS satellites, see **GPS-*Motion - Orbits*** (page 10-21).

***Example Galileo Rinex file - version 3.00 format*** lists a Rinex version 3.00 file that supports Galileo satellites.

#### 12.10.1.1 Example Galileo Rinex file - version 3.00 format

***Notes**:*

***1)** Currently, SimGEN can export data for GPS, GLONASS and Galileo satellites as Rinex version 3.00 format files - see reference jj).*
*For an example of a GPS Rinex file in version 3.00 format, see **GPS-Motion orbits-Example GPS Rinex file - version 3.00 format** (page 10-31)*


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*For an example of a GLONASS Rinex file in version 3.00 format, see **GLONASS-Motion orbits-Example GLONASS Rinex file - version 3.00 format** (page 11-20)*

***2)** Currently, SimGEN exports Rinex files using "D" to represent the decimal exponent. Reference jj) allows the decimal exponent to be one of "d", "D", "e" or "E"*

This example file listing shows the format of the Galileo Rinex version 3.00 file (the colour of the text is inverted every fifth line for readability):

```
   3.00      N: NAVIGATION DATA E: GALILEO     RINEX VERSION / TYPE
SimGEN V5.03.00   Spirent       20140820 000000 UTC PGM / RUN BY / DATE
GAL  1.0000D+02 0.0000D+00 0.0000D+00 0.0000D+00    IONOSPHERIC CORR
GAUT 0.0000000000D+00 0.000000000D+00 259200 1806     TIME SYSTEM CORR
  16                           LEAP SECONDS
                              END OF HEADER
E01 2014 08 20 00 00 00 0.000000000000D+00 0.000000000000D+00 0.000000000000D+00
   2.000000000000D+00 0.000000000000D+00 0.000000000000D+00-8.908613540482D-01
   0.000000000000D+00 0.000000000000D+00 0.000000000000D+00 5.440588203494D+03
   2.592000000000D+05 0.000000000000D+00 2.899102574558D+00 0.000000000000D+00
   9.773843811168D-01 0.000000000000D+00 0.000000000000D+00 0.000000000000D+00
   0.000000000000D+00 2.630000000000D+02 7.820000000000D+02 0.000000000000D+00
   2.500000000000D+01 0.000000000000D+00 0.000000000000D+00 0.000000000000D+00
   2.592000000000D+05 0.000000000000D+00 0.000000000000D+00 0.000000000000D+00
E02 2014 08 20 00 00 00 0.000000000000D+00 0.000000000000D+00 0.000000000000D+00
.
.
.
```

Rinex file formatting is critical - Spirent recommends you compare the example file listing above and the description of each line in the listing (given below) with the Rinex file specification in reference jj).

Where relevant, square brackets contain the units.

**Line 1**
Three columns a) to c):
Column a) Rinex version (RINEX VERSION): 3.00

Column b) Rinex Type (TYPE): N: NAVIGATION DATA

Column c) Satellite System: E: GALILEO

**Line 2**
Three columns a) to c):
Column a) Name of program creating this file (PGM): SimGEN V5.03.00

Column b) Name of agency creating this file (RUN BY): Spirent

Column c) Date and time of file creation:
For Galileo, this is the Time of Clock (TOC) see line 7 Column b)
Date and time format: yyyymmdd hhmmss UTC

**Line 3**
Four columns a) to d)

GAL a) to d) will be Gal ai0, ai1, ai2, zero (see reference r)).

(IONOSPHERIC CORR):

**Line 4**
Four columns a) to d)

GAUT = GAL to UTC a0, a1 (TIME SYSTEM CORR): Terms to compute time in UTC

Column a) Coefficient A0(A0) = a0 + (a1 * delta_t)

Column b) Coefficient A1(A1) = a1

Column c) Reference time for UTC data(T) = Galileo time-of-week for toa

Column d) UTC reference week number(W) = Galileo week number for toa.

Where:

delta_t = toa - Scenario start time

Galileo toa = Scenario start time + time for next almanac update interval epoch
(unless Scenario start time is already on an interval boundary).


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Almanac update interval is defined in reference r). For example:

i) If scenario start time is 15 Jun 2006 00:00:00 and almanac update interval is 10 minutes,
toa is same as scenario start time.

ii) If scenario start time is 15 Jun 2006 00:00:06 and almanac update interval is 10 minutes,
toa is 15 Jun 2006 00:10:00.

ao, a1 - Values of coefficients A0 and A1 in Galileo constellation - see reference r) - but SimGEN converts the coefficients from microseconds to seconds.

***Note**: Coefficient A2 is not used.*

**Line 5**
Delta time due to leap seconds (LEAP SECONDS): set in **Galileo-*System time*** (page 12-3), see **GST leads UTC by**

***Note**: You must select <**scenario**>-**Start time**-**UTC offset control-legacy(constellation file)** (page 4-15) before SimGEN can read and write UTC offset, in seconds, to and from Rinex files*

**Line 6**
(END OF HEADER)

**Line 7 to Line 14**
These lines contain navigation data for the first satellite in the constellation.

This data occupies eight rows by four columns of the file. The satellite SVID precedes the data in the first row, preceded by E for Galileo. The Rinex file shows satellites present at the scenario start.

This example listing identifies the columns of data as a) (first column) to d) (fourth column).

***Note:** You must select <**scenario**>-**Start time**-**UTC offset control-legacy(constellation file)** (page 4-15) before SimGEN can read and write UTC offset, in seconds, from and to Rinex files*

**Line 7**

Column a) PRN: Galileo Satellite PRN, prefixed with 'E' to specify the Galileo Constellation. Value should correspond to scenario.

Column b) (EPOCH): TOC (Time of Clock) Defined as the Scenario start time + the time for next ephemeris update interval (unless Scenario start time is already on an interval boundary). Set the ephemeris update interval in **Galileo-*Uplink control*** (page 12-4).

Column c) SV CLOCK: T(orb_ref_time - toe ) = seconds elapsed from orbital reference time to toe (time of ephemeris). T(orb_ref_time - toe ) = TOC(s) - scenario_start_time(s)

***Notes***:

***1)** SV clock bias [s] = Af0 +(Af1 * T(orb_ref_time - toe))+Af2* T(orb_ref_time - toe ))²*

***2)** SV clock drift [s.s-1] = Af1 + 2 * ( Af2 * T(orb_ref_time - toe ) )*

***3)** SV clock drift rate [s.s-2] = Af2*

Reference r) details Af0, Af1 and Af2 for Galileo constellations. **Galileo-*Motion - Clock errors*** (page 12-14) details defining these parameters.

**Line 8**
BROADCAST ORBIT 1

Column a) IODE: set to 2.0 (always)

Column b) Crs [m]: **Galileo-*Motion - Perturbations*** (page 10-34) defines this parameter.

Column c) Delta n [rad.$s^{-1}$]: **Galileo-*Motion - Orbits*** (page 10-21) defines this parameter (Galileo parameter is the same as the GPS parameter). The value in the scenario extrapolated forward by T(orb_ref_time - toe).

Column d) M0 [rad]: **Galileo-*Motion - Orbits*** defines this parameter (Galileo parameter is the same as the GPS parameter). The value in the scenario extrapolated forward by T(orb_ref_time - toe)

**Line 9**
BROADCAST ORBIT 2

Column a) Cuc [rad]: **Galileo-*Motion - Orbits*** (page 12-10) defines this parameter.

Column b) Eccentricity (e): **Galileo-*Motion - Orbits*** defines this parameter.

Column c) Cus [rad]: **Galileo-*Motion - Orbits*** defines this parameter.

Column d) sqrt(A) [$m^{1/2}$]: **Galileo-*Motion - Orbits*** defines this parameter. The value in scenario extrapolated forward by T(orb_ref_time - toe)


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**Line 10**
BROADCAST ORBIT 3

Column a) Toe [s]: GALILEO time-of-week based on TOC

Column b) Cic [rad]: **Galileo-*Motion - Orbits*** (page 12-10) defines this parameter.

Column c) OMEGA0 [rad]: **Galileo-*Motion - Orbits*** defines this parameter. The value in scenario extrapolated forward by T(orb_ref_time - toe)

Column d) Cis [rad]: **Galileo-*Motion - Orbits*** defines this parameter.

**Line 11**
BROADCAST ORBIT 4

Column a) i0 [rad]: s **Galileo-*Motion - Orbits*** (page 12-10) defines this parameter. The value in scenario extrapolated forward by T(orb_ref_time - toe)

Column b) Crc [m]: **Galileo-*Motion - Orbits*** defines this parameter.

Column c) omega [rad]: **Galileo-*Motion - Orbits*** defines this parameter.

Column d) OMEGA DOT [rad.$s^{-1}$]: **Galileo-*Motion - Orbits*** defines this parameter.

**Line 12**
BROADCAST ORBIT 5

Column a) IDOT [rad.$s^{-1}$]: **Galileo-*Motion - Orbits*** (page 12-10) defines this parameter.

Column b) Data sources: number represents a 9-bit number with the following internal representation:

Bit 0 set: I/NAV E1-B turned On
Bit 1 set: F/NAV E5a-I turned On
Bit 2 set: I/NAV E5b-I turned On
Bit 8 set: af0-af2, TOC are for E5a,E1
Bit 9 set: af0-af2, TOC are for E5b,E1

Bits 8 and 9 refer to the SV CLK values in Line 8.

Column c) GAL week: the GAL week number for TOC

Column d) spare

**Line 13**
BROADCAST ORBIT 6

Column a) SISA Signal-in-Space Accuracy: see reference r).

Column b) SV health: see reference r).

Bit 0: E1B Data validity Status
Bit 1-2: E1B Health Status
Bit 3: E5a Data validity Status
Bit 4-5: E5a Health Status
Bit 6: E5b Data Validity Status
Bit 7-8: E5b Health Status

Column c) BGD E5a/E1 [s]: **Galileo-*Motion - Clock errors*** (page 12-14) defines this parameter.

Column d) BGD E5b/E1[s]: see reference r). SimGEN calculates this value.

**Line 14**
BROADCAST ORBIT 7

Column a) Transmission time of message [s of GALILEO week]: Galileo time-of-week for date found in line 2 [c] of header.

Column b) to d) Spare, all set to zero.

**Line 15 onward**
Galileo Navigation Data Record for second, third and so on satellites.

#### 12.10.1.2 Geostationary satellites

***Notes:***

***1)*** *The Galileo SISICD, reference r), specifies the parameter* ***Root semi-major axis (A½)*** *as a difference with respect to a nominal semi-major axis of 29 900 km. The SISICD specifies this difference using a 13-bit number.*

*The root semi-major axis of a geostationary satellite will greatly exceed this nominal value and the difference of the semi-major axes will exceed the range of the 13-bit number.*

***2)*** *A Geostationary satellite has a value of zero for its orbital Inclination (***Io***).*


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*Both **1)** and **2)** lead to unrealistic almanac data for satellites you specify as geostationary.*

This dialog is the same as **GPS-*Make geo*** (page 10-23).

### 12.10.2 Motion - Perturbations

This dialog is the same as **GPS-*Motion - Perturbations*** (page 10-34), although parameter values may not be the same.

### 12.10.3 Motion - Track errors

This dialog is the same as **GPS-*Motion - Track errors*** (page 10-35), although parameter values may not be the same.

### 12.10.4 Motion - Clock errors

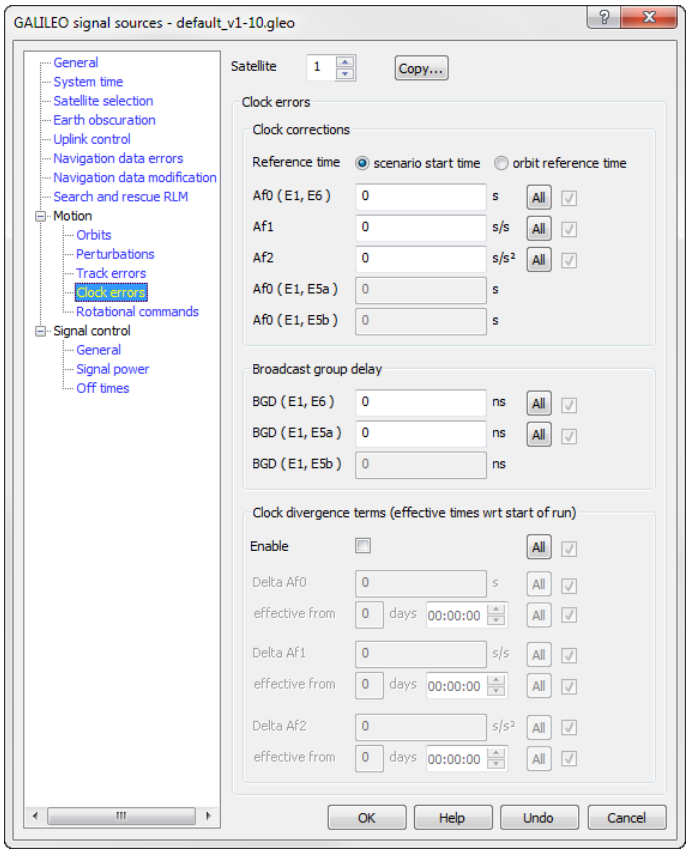
***Notes**:*

***1)** You are restricted to defining the **Clock error** parameters shown below. As they are inter-related, you cannot specify values for all **Clock error** parameters. An inappropriate choice of values would result in inconsistent signal timing between the different frequencies.*

***2)** The broadcast values of Af0, Af1, BGD(E1, E5a) and BGD(E1, E5b) may change during the scenario if Af1 and/or Af2 are non-zero.*

Use the **Clock errors** dialog to apply errors to specify clock corrections, broadcast group delay and clock divergence for each Galileo **Satellite**. Clock corrections describe satellite clock drift over time referenced to the scenario start time.

Clock divergence simulates satellite clock drift deviation from that described in the Navigation Data message. SimGEN adds clock divergence to the RF signal only.





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The Navigation Data broadcast by each Galileo satellite defines separate sets of satellite clock correction data (**Af0**, **Af1** and **Af2**) and broadcast group delay (**BGD**) values for the frequency combinations E1-E5a, E1-E5b and E1-E6.

The user-defined BGD parameters shown in the following table, determine the initial values of BGD (E1,E5b) as shown in **Motion-Clock errors-Broadcast group delay**.

| Parameter | Comment |
|---|---|
| **Af0 (E1, E6)** | User-defined |
| **Af1** | User-defined, common to all frequencies |
| **Af2** | User-defined, common to all frequencies |
| **Af0 (E1, E5a)** | Displays calculated values SimGEN will use |
| **Af0 (E1, E5b)** | Displays calculated values SimGEN will use |
| **BGD (E1, E6)** | User-defined |
| **BGD (E1, E5a)** | User-defined |
| **BGD (E1, E5b)** | Displays calculated value SimGEN will use |

You cannot directly change BGD (E1,E5b) it is for information only. The difference between the (E1,E5a) and (E1,E5b) components is the result of their realisation as sideband frequencies of the nominal E5 frequency.

SimGEN calculates the BGD values (using a number of inter-related parameters) from the values you enter in the **Broadcast group delay** area.

| | | | |
|---|---|---|---|
| **Clock corrections** | Specify the zero-order to second-order clock corrections. The zero-order corrections are frequency dependent. | | |
| **Reference time** | Up to SimGEN 2-90, SimGEN applied clock error coefficients relative to the scenario start time, instead of using the orbital data reference time. Changing the scenario start time could result in large (over-ranging) clock terms, which are not ideal if you want to, for example, duplicate Yuma almanac data; or run two tests with a small difference in start time and see continuity in the clock effects.<br>Choose from: | | |
| | **scenario start time** (default): references clock correction terms to the scenario start time (giving backwards compatibility)<br>**orbit reference time**: references clock correction terms to the orbital reference time | | |
| **Af0 (E1, E6)** | Units: seconds | Range: ±0.062 5 s | Default: 0 |
| **Af1** | Units: seconds per second | Range: ±1.490 1E-8 $s.s^{-1}$ | Default: 0 |
| **Af2** | Units: seconds per $(second)^2$ | Range: ±5.384E-17 $s.s^{-2}$ | Default: 0 |
| ***Note***: *The broadcast values of Af0, Af1, BGD(E1,E5a) and BGD(E1,E5b) may change during the scenario if Af1 and/or Af2 are non-zero.* | | | |
| **Broadcast group delay** | Specify the inter-signal group delay | | |
| **BGD (E1, E6)** | Units: nanoseconds | Range: -119.209 to 118.976 ns | Default: 0 |
| **BGD (E1, E5a)** | Units: nanoseconds | Range: -119.209 to 118.976 ns | Default: 0 |
| ***Notes***:<br>***1)*** *The dialog shows BGD(E1,E5b) for information only.*<br>***2)*** *The broadcast values of Af0, Af1, BGD(E1,E5a) and BGD(E1,E5b) may change during the scenario if Af1 and/or Af2 are non-zero.* | | | |


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| | | | |
|---|---|---|---|
| **Clock divergence terms** (effective times wrt start of run) | These terms are analogous to the Clock correction terms Af0, Af1 and Af2. However, Clock divergence applies only to signal timing and not to the navigation data.<br>Clock divergence specifies how the satellite clock differs from the behaviour predicted by the ground station and specified in Clock corrections. You can use Clock divergence to simulate an error in signal timing, which may be due to a clock or range error.<br>Use Effective from to insert a clock error during a simulation.<br>Select Enable to enable clock divergence for all satellites. | | |
| **Delta Af0** | Units: seconds | Range: ±.0.025 s | Default: 0 |
| ***Note***: *Setting **Delta Af0** is equivalent to applying a constant pseudorange error to that satellite.* | | | |
| **Delta Af1** | Units: seconds per second | Range: ±1E-5 $s.s^{-1}$ | Default: 0 |
| **Delta Af2** | Units: seconds per $(second)^2$ | Range: ±1E-12 $s.s^{-2}$ | Default: 0 |
| **effective from** | Units:<br>d hh:mm:ss | Range:<br>0 days 00:00:00<br>to 23 days 23:59:59 | default:<br>0 days 00:00:00 |

### 12.10.5 Motion - Rotational commands

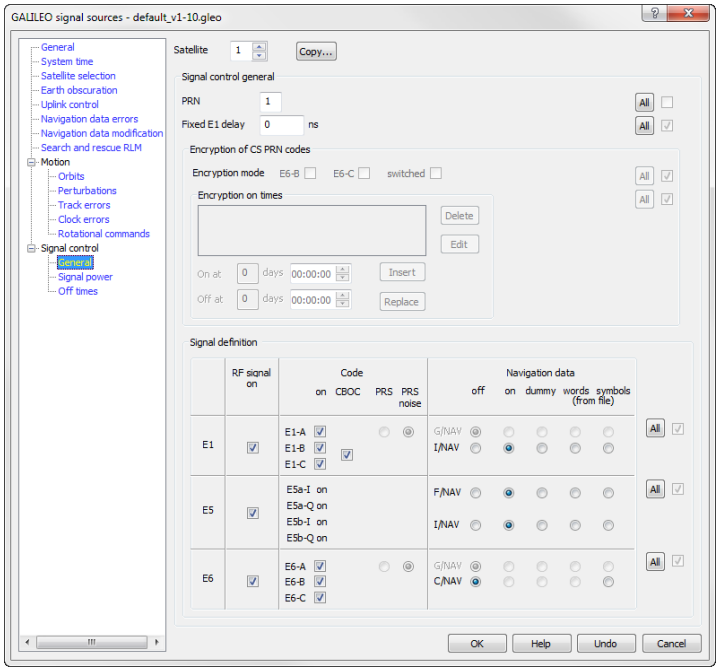
This dialog is the same as **GPS-*Motion - Rotational commands*** (page 10-38).

## 12.11 Signal control

### 12.11.1 Signal control - General

***Note**: Each satellite broadcasts a different Pseudo-Random sequence.*

This figure shows the dialog:




| | |
|---|---|
| **Satellite** | Type the SVID you want to use |
| **PRN** | The Pseudo-Random-Noise code the **Satellite** transmits.<br>Default: **PRN** set to the same number as **Satellite** (SVID). |


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| | | | |
|---|---|---|---|
| ***Note**: Spirent recommends you always set the satellite **PRN** to be identical to **Satellite** (the satellite SVID). SVID identifies the satellite in the broadcast almanac. The ability to change PRN is useful for special test purposes, such as testing two satellites with the same PRN.* | | | |
| **Fixed E1 delay** | Use when you select ***Atmosphere file*-Ionospheric model-Ionospheric delay models-Fixed** (page 9-1). SimGEN adds the E1 delay to the E1 RF pseudorange. The E5 and E6 delays are set proportionally. | | |
| | Units: nanoseconds | Range: 0 to 500 ns | Default: 0 |
| **Encryption of CS PRN codes** | Disabled for Open Service users | | |


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| | **Signal definition** | Controls generation of the Galileo frequencies, their respective PRN codes and Navigation data. | | | |
|---|---|---|---|---|---|
| **Carrier** | **RF signal on** | **Code** | | **Navigation data** | |
| **E1** | Select (default): on<br>Deselect: RF signal off | **E1-A**<br>**E1-B**<br>**E1-C**<br><br><br>**CBOC**<br><br><br><br>**PRS**<br>**PRS noise** | Select (default): on<br>Select (default): on<br>Select (default): on<br>Deselect: off<br><br>Select (default): on<br>Deselect: off<br>See Note 7)<br><br>(disabled) set off<br>(disabled) set on<br>See Note 1) | **G/NAV**<br><br>**I/NAV** | (disabled) set **off**<br><br>**on** (default)<br>Select from:<br>**off**<br>**dummy** see Notes 4) and 5), and reference r)<br>**words (from file)** see Note 5)<br>**symbols (from file)** see Notes 5) and 6) |
| **E5** | Select (default): on<br>Deselect: RF signal off | <br>**E5a-I**<br>**E5a-Q**<br><br>**E5b-I**<br>**E5b-Q** | See Note 2)<br>Permanently **on**<br>Permanently **on**<br><br>Permanently **on**<br>Permanently **on** | **F/NAV**<br>and<br>**I/NAV** | **on**(default) see Note 3)<br><br>Select from:<br>**off**<br>**dummy** see Notes 4) and 5), and reference r)<br>**words (from file)** see Note 5)<br>**symbols (from file)** see Notes 5) and 6) |
| **E6** | Select (default): on<br>Deselect: RF signal off | **E6-A**<br>**E6-B**<br>**E6-C**<br><br><br>**PRS**<br>**PRS noise** | Select (default): **on**<br>Select (default): **on**<br>Select (default): **on**<br>Deselect: **off**<br><br>(disabled) set **off**<br>(disabled) set **on**<br>See Note 1) | **G/NAV**<br><br>**C/NAV** | (disabled) set **off**<br><br>**off** (default)<br>or select:<br>**symbols from file** see Notes 5) and 6) |

***Notes**:*

***1)** You can use **PRS noise** to determine the effect of the PRS signal on your receiver.*

***2) PRS noise** is not available for E5 carriers.*


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***3)*** ***Ranging data files*** *(page 12-22) details the format of the PRN coded ranging data file and its location. Reference r) details generation of I/NAV authentication data.*

***4)*** *For both F/NAV and I/NAV, SimGEN v2-81 onward can generate dummy pages (a repeating sequence of ones and zeroes) as defined in reference r) but see Note 5). For Open Service users, Spirent applies a sequence of ones and zeroes to reserved fields, as defined reference r), ERIS and regional status fields.*

***5)*** *For Open Service users, SimGEN defaults to* ***on*** *and generates navigation data.*
*To maintain backwards compatibility, Open Service users can continue to use* ***dummy pages****,* ***Navigation data words from file*** *and* ***Navigation data symbols from file****.*

***6)*** *When using* ***Navigation data from symbols*** *(page 12-25) SimGEN loads the file directly to the signal generator and does not perform any further operations on the symbol stream.*

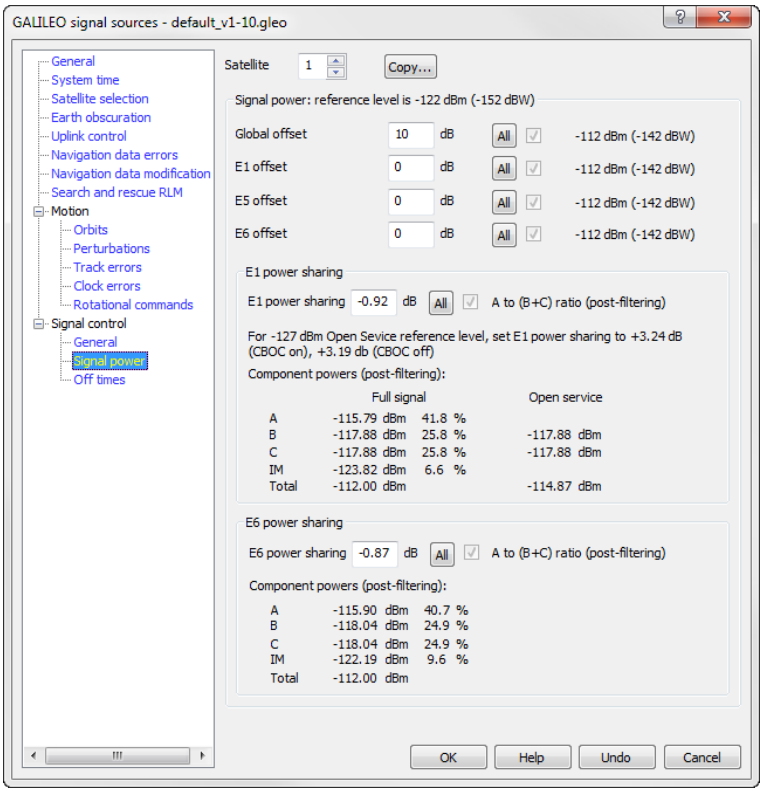
***7)*** *From Galileo signal sources file default_v1-06.gleo onwards, SimGEN's default is* ***Code-CBOC*** *selected, which applies CBOC to both E1-B and E1-C.*


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## 12.11.2 Signal control - Signal power

***Note**: If your antenna pattern file, see **Receive and transmit antennas** (page 23-1), includes negative figures (in other words, gain) there is a possibility the sum of the RF power level you specify in the constellation file and the antenna gain will exceed the maximum power capability of your signal generator. If this occurs during a scenario, the power level will limit at the maximum capability of the signal generator:*
*+20 dB for GSS9000-series, GSS8000-series and GSS77xx signal generators*
*+15 dB for the GSS7000, GSS6700 (and the superseded GSS6560) signal generator.*

Use this dialog to set the RF power of the simulated signals from each Galileo satellite. The signal power reference level is -122 dBm (-152 dBW), the minimum signal level in reference r).




| | | | |
|---|---|---|---|
| **Satellite** | Type the SVID you want to use. | | |
| **Signal power: reference level is -122 dBm (-152 dBW)** | Controls all signal levels from **Satellite** (using all simulated carrier frequencies) at the signal generator. The area title gives the reference level in dBm and dBW.<br>You can use one of two modes of operation, ***General*-Signal Strength-Fixed** or **-Modelled** (page 12-3). | | |
| **Global Offset,**<br>**E1 offset,**<br>**E5 offset,**<br>**E6 offset** | Units: decibels with respect to the minimum level in reference r) | Range: -20.0 to 26.0 dB | Default:<br>10 (Global)<br>0 (E1, E5, E6) |


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| | | | |
|---|---|---|---|
| **E1 power sharing** | Sets the post-filtering power-sharing ratio E1A to (E1B+E1C).<br>For power sharing consistent with previous versions of SimGEN, keep **E1 Power Sharing** at the default -0.92 dB.<br><br>SimGEN uses the area under the **E1 power sharing** text box to show the individual component powers.<br><br>GSS7000 and GSS6700 signal generators only generate the 'Open Service' codes E1-B and E1-C, giving the component and total powers shown in the 'Open service' column of the dialog.<br><br>GSS9000-series, GSS8000-series (and the superseded GSS7800) signal generators also generate E1-A and the IM signal to give the 'Full signal', giving the component and total powers shown in the 'Full signal' column of the dialog. This column also shows the percentage power in each component.<br><br>**E1 power sharing** values to achieve the Open Service ICD reference level:<br>+3.24 dB with CBOC selected (default, see ***Signal control - General*** (page 12-16))<br>+3.19 dB with CBOC deselected | | |
| | Units: decibels | Range: -3.5 to 3.5 dB | Default: -0.92 |
| **E6 power sharing** | Sets the post-filtering power-sharing ratio E6A to (E6B+E6C).<br>For power sharing consistent with previous versions of SimGEN, keep **E6 Power Sharing** at the default -0.87 dB.<br><br>SimGEN uses the area under the **E6 power sharing** text box to show the individual component powers (post filtering). | | |
| | Units: decibels | Range: -3.5 to 3.5 dB | Default: -0.87 |

## 12.11.3 Signal control - Off times

This dialog is the same as **GPS-*Signal Control - Off times*** (page 10-50)

### 12.11.3.1 Ranging data files

***Note**: The signal generator firmware generates ranging data codes for PRS Noise (E6-A and E1).*

Spirent provides ranging data files (corresponding to those defined in the latest available OS ICD, reference r). You can use the syntax in the following sections to modify these files.

Spirent supplies dummy PRN files for E6B and E6C.

This table details the syntax of the ranging file, shown in this example

***!<comment>***
***GPID <id>***
***GPLO Δ <prnid> Δ < code > Δ <len> Δ <ASCII data>***
***GPLO Δ <prnid> Δ < code > Δ <len>↵<ASCII data>***
***…***

| Data set | Description |
|---|---|
| ***<comment>*** | Ignores any line starting with '!' |
| ***GPID*** | Command "Galileo Prn ID"<br>***Note**: Another set of codes in a different set of files would have a different GPID.* |
| ***<id>*** | ID of this set of PRN codes. SimGEN uses <id> to identify the set of codes currently loaded in the simulator.<br>GPID<id> is defined once at the start of all corresponding files in that set.<br>GPID<id> must be the same for all corresponding files in the PRN set. |
| ***GPLO*** | "Galileo Prn LOad"<br>Loads this set of PRN codes to the signal generator |
| ***Δ*** | Space character |


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| Data set | Description |
|---|---|
| ***<prnid>*** | Identifies a set of available PRN codes to be allocated to a particular satellite in the constellation.<br>Integer value, range 1 to 50 |
| ***<code>*** | As specified below (P - primary code, S - secondary code): |
| | E1-BP (4092 chips)<br>E1-CP (4092 chips)<br>E1-CS (1-128 chips)<br><br>E5a-IP (10230 chips)<br>E5a-QP (10230 chips)<br><br>E5b-IP (10230 chips)<br>E5b-QP (10230 chips)<br><br>E5a-IS (20 chips)<br>E5b-IS (4 chips)<br><br>E5a-QS (1-128 chips)<br>E5b-QS (1-128 chips)<br><br>E6-BP (5115 chips)<br>E6-CP (5115 chips)<br>E6-CS (100 chips) |
| ***<len>*** | Length in bits |
| ***<ASCII data>*** | The PRN code written as pairs of ASCII hexadecimal characters (bytes) and optionally separated by a space.<br>Each character pair (byte) represents eight bits of code.<br>The first PRN bit corresponds with the most significant bit of the first character.<br>If length is not a multiple of eight, then any spare bits in the last byte shall be set to zero. |

Prepare the data as a set of files, one for each signal frequency and component, as set out below.

- → The files must contain an identical GPID command and the required number of GPLO messages concatenated together for all satellites.
- → You may optionally insert whitespace characters between messages.
- → During the “Arming” phase of a simulation, SimGEN:
- → Opens the ranging data files and determines the GPID.
- → Interrogates the signal generator for the GPID of the loaded PRN codes.
- → Determines if the GPID codes are equal. If the GPID are not equal, SimGEN loads the complete set of 50 PRN codes per signal component to the signal generator.

The signal generator does not permanently store PRN codes. They are lost when you turn off ac power to the signal generator.

To assign a PRN to a satellite, open the ***Signal control - General*** (page 12-16) dialog and type the PRN for the satellite in **PRN**. You can assign one PRN to be used for all satellites (by clicking **All**); or you can assign a different PRN for each satellite (by typing the PRN for each satellite SVID).

### 12.11.4 Filename and location

***Notes****:*

***1)*** *Ensure the folder C:\Program Files\Spirent Communications\Positioning Application\Galileo Datafiles Backup exists on your system. If this folder does not exist, you must create it before continuing to use ranging files*

***2)*** *From SimGEN version 2-83 SR02 onwards, Spirent includes details for E1B and E1C for backwards compatibility. By default, SimGEN version 2-83 SR02 onwards generates this data*

***3)*** *For backwards compatibility, Spirent retains the use of L1 in certain Galileo filenames*

You must name the ranging data file *Galileo_prns_xxx.dat*, where “xxx” represents the signal frequency and component of the PRN code it contains. See the files:

*Galileo_prns_E1_B.dat*
*Galileo_prns_E1_C.dat*

*Galileo_prns_E5a_I.dat*
*Galileo_prns_E5a_Q.dat*


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*Galileo_prns_E5b_I.dat*
*Galileo_prns_E5b_Q.dat*

*Galileo_prns_E6_B.dat*
*Galileo_prns_E6_C.dat*

Save the ranging file in the folder *D:\posapp\software\<version>\gui \Galileo_data_sets*
(for GSS8000-series and earlier signal generators *C:\Program Files\Spirent Communications\Positioning Application\Galileo_data_sets)*

You can modify or replace these files, as long as you retain the appropriate name. Spirent recommends you edit copies of the files. Before you edit any files copy the original files to the folder *C:\Program Files\Spirent Communications\Positioning Application\Galileo Datafiles Backup.*

## 12.12 Navigation data from words

***Note**: These details are included for backwards compatibility.*

For each navigation data stream, you can specify a data set of navigation data word bits of arbitrary length. The dataset length must be a multiple of the number of navigation data word bits per page for that stream.
For example, the dataset length for F/NAV (E5a) must be a multiple of 244 bits.

At the end of the defined sequence, SimGEN repeats the sequence.

For F/NAV and I/NAV, SimGEN:

- → Reads in a page of navigation data word bits
- → Resets any tail bits
- → Calculates and overwrites the CRC field in the page
- → Generates the FEC symbol stream
- → Performs interleaving for transmission

The navigation data from words file must contain data sets for each message type. This table details the syntax of the ranging file, shown in this example

***!<comment>***

***<time>***

***<ID> Δ <svid> Δ <len> Δ <ASCII data>***

***<ID> Δ <svid> Δ <len> Δ <ASCII data>***

***...***

| Data set | Description |
|---|---|
| **<comment>** | Ignores any line starting with '!'<br><br>***Note**: The special keyword '!test data' tells SimGEN not to check the scenario start time with the start time supplied by the file, during arming.* |
| **<time>** | Scenario start time with format "DD-MMM-YYYY HH:MM:SS"<br>For example: "01-May-2005 23:59:30" |
| **<ID>** | E1-B, I/NAV: 240 bits per page<br>E5a, F/NAV: 244 bits per page<br>E5b, I/NAV: 240 bits per page |
| **Δ** | Space character |
| **<svid>** | Integer value, range 1 to 36 |
| **<len>** | Length in bits |


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| Data set | Description |
|---|---|
| **<ASCII data>** | Navigation data.<br>Written as pairs of ASCII hexadecimal characters (bytes), optionally separated by a space.<br>Each character pair represents eight data bits (byte).<br>The first navigation data bit corresponds with the most significant bit of the first character.<br>If length is not a multiple of eight, then any spare bits in the last byte shall be set to zero. |

Whitespace characters may separate the data sets.

### 12.12.1 Filename and location

***Notes**:*

***1)** These details are included for backwards compatibility.*

***2)** For F/NAV, the first page in the file must be the page starting immediately before, or at, the start time of the scenario.*

***3)** For I/NAV, the first page in the file must be the page starting at the start time of the scenario.*

***4)** When two signal components of a particular navigation data type are offset with respect to each another, the first page in the file will correspond to the delayed time of that stream, with respect to the stream with a sequence starting at t=0.*

***5)** The data in the navigation data file from the start of the simulation up to the delayed time is a page of all zero word bits*

***6)** Ensure the folder C:\Program Files\Spirent Communications\Positioning Application\Galileo Datafiles Backup exists on your system. If this folder does not exist, you must create it before continuing to use ranging files*

***7)** For backwards compatibility, Spirent retains the use of L1 in certain Galileo filenames*

You must prepare this data in a set of files, one for each navigation data signal component. Name the files *Galileo_nav_in_xxx.dat,* where xxx represents the navigation data signal component contained within the file, as shown below:

E1-A: *Galileo_nav_in_words_L1_A.dat*
E1-B: *Galileo_nav_in_words_L1_B.dat*

E5a: *Galileo_nav_in_words_E5a.dat*
E5b: *Galileo_nav_in_words_E5b.dat*

E6-A: *Galileo_nav_in_words_E6_A.dat*
E6-B: *Galileo_nav_in_words_E6_B.dat*

You must save these files in the folder *D:\posapp\software\<version>\gui \Galileo_data_sets* (for GSS8000-series and earlier signal generators *…\Positioning Application\Galileo_data_sets*).

I/NAV example:

The L1-B stream is one second behind the E5b stream.
Therefore, the first page, as defined in the L1-B file for this stream, will start one second into the scenario.
The first second in the navigation data file comprises all zero word bits.

## 12.13 Navigation data from symbols

***Notes**:*

***1)** These details are included for backwards compatibility.*

***2)** For F/NAV only, the first page in the file must be the page starting immediately before, or at, the start time of the scenario.*

***3)** For I/NAV only, the first page in the file must be the page starting immediately at the start time of the scenario.*

***4)** SimGEN only reads Navigation Data from symbols it does not modify the symbols.*

Each Navigation Data from symbols file is an ASCII format file. You can view and edit these files using an editor such as “Wordpad”.


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For each Navigation data stream, you must specify a set of symbols of arbitrary length. There is a restriction that this length must be a multiple of the number of symbols per page for that stream, that is, a multiple of 500 symbols for F/NAV (E5a). At the end of the defined sequence, the sequence repeats.

If the data is to be realistic (and not just have the correct CRC, FEC and interleaving) it must be supplied for the duration of the simulation.

SimGEN transmits the symbols from the file as they are read.

The navigation data from symbols file must contain data sets for each message type. This table details the syntax of the ranging file shown in this example:

!<comment>
<time>
<ID> Δ <svid> Δ <len> Δ <ASCII data>
<ID> Δ <svid> Δ <len> Δ <ASCII data>
...

| Data set | Description | |
|---|---|---|
| **<comment>** | Ignores any line starting with '!' | |
| ***Note**: The special keyword !testdata tells SimGEN not to check the scenario start time with the start time supplied by the file, during arming.* | | |
| **<time>** | Scenario start time with format "DD-MMM-YYYY HH:MM:SS"<br>For example: "01-May-2005 23:59:30" | |
| **<ID>** | E1-A<br>E1-B<br><br>E5a<br>E5b<br><br>E6-A<br>E6-B | 660 symbols per page, six seconds at 110 symbols per second<br>500 symbols per page, two seconds at 250 symbols per second<br><br>500 symbols per page, 10 seconds at 50 symbols per second<br>500 symbols per page, two seconds at 250 symbols per second<br><br>660 symbols per page, six seconds at 110 symbols per second<br>1 000 symbols per page, one second at 1 000 symbols per second |
| ***Δ*** | Space character | |
| **<svid>** | Integer value, range 1 to 36 | |
| **<len>** | Length in bits | |
| **<ASCII data>** | Navigation data symbols written as pairs of ASCII hexadecimal characters (bytes), optionally separated by a space.<br>Each character pair (byte) represents eight bits (byte).<br>The first navigation data symbol bit corresponds with the most significant bit of the first character.<br>If the message length is not a multiple of eight, then any spare bits in the last byte shall be set to zero. | |

Whitespace characters may separate the data sets.


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### 12.13.1 Filename and location

***Notes**:*

***1)** Ensure the folder C:\Program Files\Spirent Communications\Positioning Application\Galileo Datafiles Backup exists on your system. If this folder does not exist, you must create it before continuing to use ranging files*

***2)** For backwards compatibility, Spirent retains the use of L1 in certain Galileo filenames*

The PRN codes for all Galileo frequencies and signals are located in the folder *D:\posapp\software\<version>\gui \Galileo_data_sets* (for GSS8000-series and earlier signal generators *…\Positioning Application \Galileo_data_sets*).

This folder contains the following sample files:

E1-A: *Galileo_nav_in _L1_A.dat*
E1-B: *Galileo_nav_in _L1_B.dat*

E5a: *Galileo_nav_in _E5a.dat*
E5b: *Galileo_nav_in _E5b.dat*

E6-A: *Galileo_nav_in _E6_A.dat*
E6-B: *Galileo_nav_in _E6_B.dat*


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# 13 Quasi-Zenith constellation editor

***Licenced feature**: You will need a licence to use this feature. Contact Spirent for licencing details.*

The Quasi-Zenith constellation offers an augmentation service over Japan and Australia. Quasi-Zenith satellites will provide signals from a high elevation angle giving improved navigation services for mountainous areas and urban canyons. Quasi-Zenith offers:

- GPS-compatible L1C, L1C/A, L2C and L5 signals, which will improve the availability of navigation services
- Augmentation signals (SAIF and LEX) for GPS

This table gives the Quasi-Zenith constellation frequencies and reference levels, and identifies Spirent signal generator support for Quasi-Zenith signals:

| Signal | Carrier centre frequency, MHz | Power reference level, dBm | Spirent signal generator support |
|---|---|---|---|
| L1C/A | 1575.42 | -128.5 | GSS9000-series, GSS8000-series, GSS7000 and GSS6700 |
| L1-SAIF | 1575.42 | -131.0 | GSS9000-series, GSS8000-series and GSS7000 |
| L2C | 1227.60 | -136 | GSS9000-series, GSS8000-series and GSS7000 |
| L5 | 1176.45 | -124.9 (total for I and Q) | GSS9000-series, GSS8000-series and GSS7000 |
| L1C | 1575.42 | -127.0 | GSS9000-series and GSS8000-series |
| LEX | 1278.75 | -125.7 (total) | Currently, Spirent does not support LEX |

Reference q) gives the Quasi-Zenith ICD.

To use Quasi-Zenith, you may need to upgrade the FPGA release and/or firmware issue of each signal generator card installed in your signal generator. To find the firmware version and FPGA image of your signal generator cards and then determine if your signal generator needs upgrading, Spirent recommends you follow this procedure:

- Read the section on the menu item **Options-*Hardware Configuration*** (page 5-18), then display your signal generator configuration
- Select your signal generator
- Click **Output details…**
- Contact Spirent Global Services and provide the relevant details from the configuration window.
- Spirent Global Services will then determine if your signal generator needs upgrading and provide details on the upgrade procedure.

The Quasi-Zenith constellation editor is similar to the ***GPS constellation editor*** (page 10-1). If this Chapter on the Quasi-Zenith constellation editor does not give details for a scenario parameter, see the details for the parameter with the same name in the ***GPS constellation editor***.

The **Quasi-Zenith constellation-Signal sources file** characterises the Quasi-Zenith satellites in a simulation. This file is often known as the “Quasi-Zenith Constellation file”, and is one of the source files defining a scenario. The default signal sources filename for the Quasi-Zenith constellation is *default_vx-yy.qz*, where *x-yy* is the issue number.

This table shows the Quasi-Zenith utilities available in SimGEN.

| Utility name |
|---|
| ***L1C/A Navigation Data Extract utility*** (page 26-54) |


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| Utility name |
| --- |
| *GPS/QZ L1C Nav Data Extract Utility* (page 26-54) |
| *L2/L5 CNAV Navigation Data Extract Utility* (page 26-56) |
| *SAIF Nav Data Extract utility* (page 26-57) |

To use the Quasi-Zenith constellation, first see **Receive and transmit antennas-*Associate a GNSS signal with an antenna*** (page 23-4) and associate the appropriate signal with the antenna(s) you want to use.

# 13.1 Information on satellite SVID and PRN

***Note**: Spirent recommends you change SimGEN's default Quasi-Zenith PRN's with caution, since SimGEN generates navigation data with respect to the satellite's SVID and not its PRN.*

SimGEN denotes each satellite in the Quasi-Zenith constellation by a satellite number (the SVID). Internally, SimGEN uses the satellite's SVID to identify the control data it must apply to individual Quasi-Zenith satellites.

SVID and PRN are not synonymous for Quasi-Zenith satellites, as their PRN values are much larger and each Quasi-Zenith satellite broadcasts several signals using different PRNs.

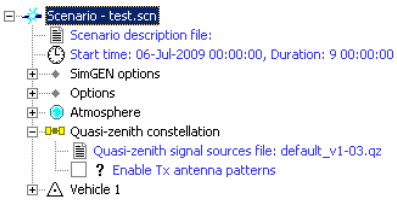
# 13.2 Quasi-Zenith constellation editor

***Note**: The range of parameter values you can enter in PosApp may be different from the values commonly used in satellite navigation systems.*

Use the constellation editor to edit data in the Quasi-Zenith constellation file. The editor shows the data in the Quasi-Zenith constellation file as a series of "pages". The left-hand area shows the pages you can select for editing, the right-hand area shows the details of the page you selected in the left-hand area. This section describes how you select and change details in the right-hand area.

SimGEN checks the range of the value you type in a text box and, if incorrect, displays the range of acceptable values.

After associating the Quasi-Zenith signal type with an antenna, the Quasi-Zenith constellation file appears in the **Scenario contents** window:




**Receive and transmit antennas-*Transmitter antenna level and phase*** patterns (page 23-20) details creating and applying **Tx antenna patterns**.

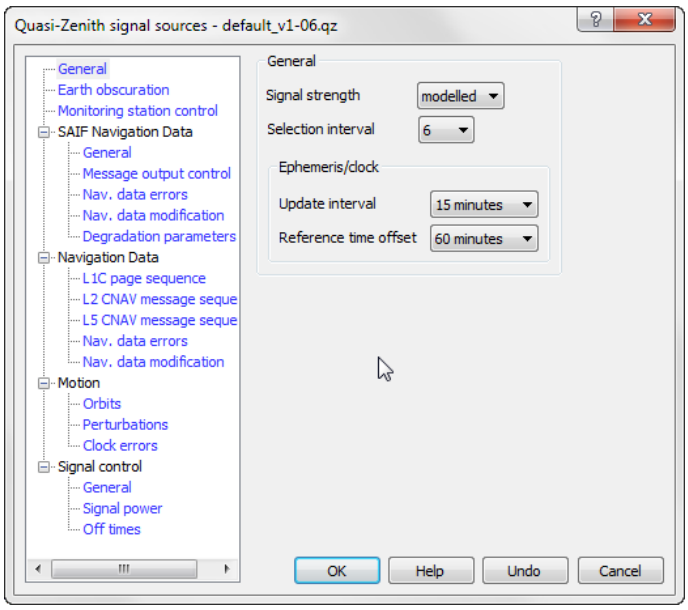
Edit the Quasi-Zenith constellation file in the same way as you would edit a GPS constellation file. First, expand **Quasi-zenith constellation**. Then:

→ Select **Quasi-zenith constellation-Signal sources file**

→ Right-click and select **Edit**

→ You will see the **Signal sources-General** dialog, shown below. The Quasi-Zenith signal sources file has the default name, *default_vx-yy.qz*.


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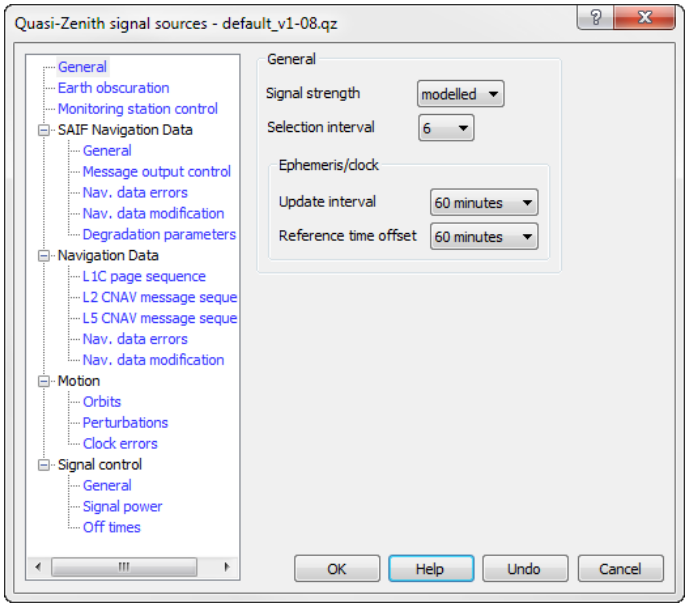



The left-hand area of the **Signal sources** dialog shows the titles of all “pages” you can edit in the file. Click on a title to edit it.

After editing the **Signal sources file**, click **OK** then save the file to a name of your choice using the dialog. Select **Shared** to save this file to the shared folder, so making it available to other scenarios.

## 13.3 General

Use the **General** dialog, to edit the parameters affecting all Quasi-Zenith satellites:




| | |
|---|---|
| **Signal strength** | Select whether SimGEN modifies satellite signal-levels based on satellite-to-antenna distance or uses a fixed signal level. **GPS-*General - Modelled and fixed signal strength*** (page 10-8) gives further details on **Modelled** and **Fixed**. In each case, first set the base RF power level using ***Signal control - Signal power*** (page 13-25) |
| | Choose from: |
| **Modelled** | (default) SimGEN modifies satellite signal level as a function of the satellite to receiver antenna distance in proportion to 1/(distance)$^2$ |
| **Fixed** | SimGEN does not modify the signal level as a function of satellite to receiver antenna distance. |


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| | |
|---|---|
| **Sampling interval** | The interval at which SimGEN revises the simulated set of Quasi-Zenith satellites. In general and if there are sufficient channels, SimGEN simulates all visible satellites so this set will change only when a Quasi-Zenith satellite rises or sets (disappears from view). ***Earth obscuration*** (page 10-11) defines the visibility criteria.<br>Spirent recommends you use the default value of six seconds. |
| **Ephemeris/clock** | Choose the ephemeris and clock update interval, and reference time offset - see reference q). |
| **Update interval** | The update interval, in minutes, SimGEN applies to the broadcast ephemeris and clock data.<br>Choose from:<br>**15**<br>**30**<br>**45**<br>**60** (default for files created up to SimGEN version 5.04 and for SimGEN version 5.06SR01 onwards) |
| **Reference time offset** | The offset, in minutes, from the nominal data-set cutover time.<br>SimGEN applies this offset to both ephemeris and clock reference time.<br>Choose from:<br>**0**<br>**60** (default for new and existing constellation files)<br>**120** |
| ***Note**: Up to version 5.04, SimGEN applied fixed update intervals of 60 minutes for ephemeris data and 15 minutes for clock data, with no offset between the update and reference times.* | |

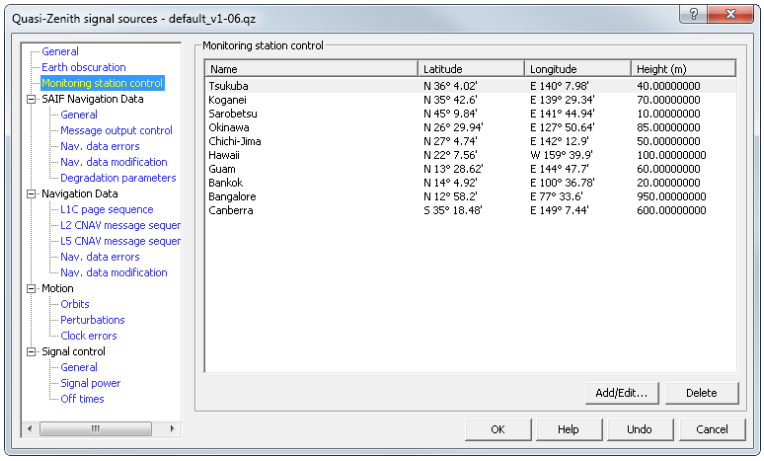
## 13.4 Earth obscuration

Use this dialog to determine how SimGEN calculates Quasi-Zenith satellite obscuration by the Earth's surface, it is the same dialog as in **GPS-*Earth obscuration*** (page 10-11).

## 13.5 Monitoring station control

***Note**: Normally, you would define at least one monitoring station in the region of the simulated vehicle(s). SimGEN uses Monitoring station locations to determine the SAIF covariance matrix and any other Quasi-Zenith parameters relating to ground station measurements. This requires line-of-sight visibility to at least four ground-monitoring stations. A message warns you if you attempt to delete the fourth ground-monitoring station.*

Use this dialog to define the locations of Quasi-Zenith ground stations:



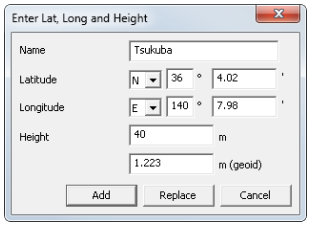

To enter the location of a ground station:

→ Open the **Signal sources-Monitoring station control** dialog, shown above.

→ Click **Add/Edit...** to open the **Enter Lat**, **Long and Height** dialog shown below; alternatively, select the station you want to edit and double-click.


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→ Click **Add** or **Replace** after completing the appropriate entry.




| | | | |
|---|---|---|---|
| **Name** | Type a name for the new Monitoring station | | |
| **Latitude** | Type the latitude of the new Monitoring station | | |
| | Units: degrees, minutes | Range: N 90° 0.0´ to S 90° 0.0´ | |
| **Longitude** | Type the longitude of the new Monitoring station | | |
| | Units: degrees, minutes | Range: W 180° 0.0´ to E 180° 0.0´ | |
| **Height** | Type the height of the new Monitoring station | | |
| | Units: metres | Range: -9 999 to +30 000 m | Default: 0 (-18 geoid) |

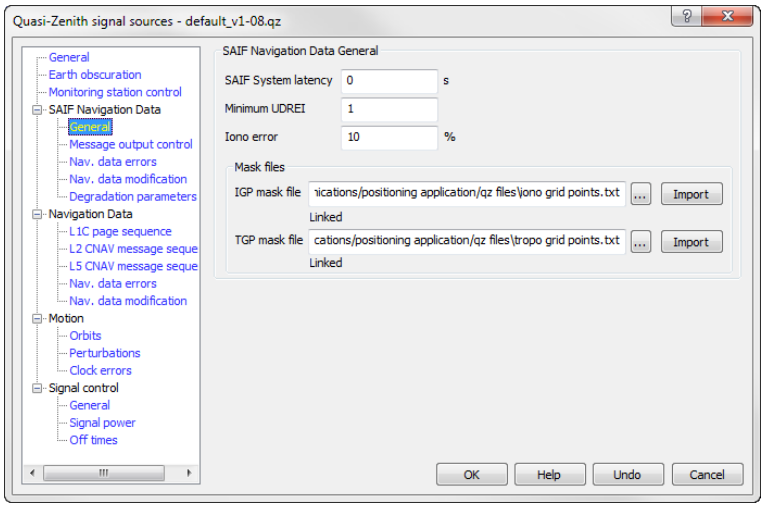
To delete a monitoring station, select the station and click **Delete**.

## 13.6 SAIF Navigation Data

Use the dialogs in the following sections to enter data for the contents of L1-SAIF messages. **SimGEN utilities-** ***SAIF Nav Data Extract utility*** (page 26-57) describes a SimGEN utility for decoding the simulated SAIF messages.

### 13.6.1 SAIF Navigation Data - General

Set general parameters for the **SAIF Navigation Data** message using this dialog:




| | | | |
|---|---|---|---|
| **SAIF System latency** | Defines the value of the system delay ($t_{lat}$), included in the Fast Correction Degradation message (MT7). | | |
| | Units: seconds | Range: 0 to 15 s | Default: 0 |
| ***Note***: *SimGEN does not use this value when it assigns Fast Correction data for message types 2 to 5* | | | |


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| | | | |
|---|---|---|---|
| **Minimum UDREI** | Spirent assumes the minimum UDREI value applies at the centre of the local Quasi-Zenith region (the mean of the ground station locations). SimGEN uses the minimum UDREI to determine the nominal measurement accuracy and uses it with the covariance matrix to determine the UDREI values corresponding to the current location of individual satellites. | | |
| | Units: none | Range: 0 to 13 | Default: 1 |
| **Iono error** | Defines the percentage error SimGEN applies to all atmospheric delay measurements. SimGEN uses this to determine GIVEI values at each iono monitoring point in use. | | |
| | Units: percent | Range: 0 to 100 % | Default: 10 |
| **Mask files** | | | |
| **IGP mask file** | Select the file defining the locations of the valid points in the Ionospheric Grid Mask.<br>***SAIF Navigation Data - Iono grid-point format*** (page 13-6) defines this grid-point format.<br><br>Click **…** to navigate to an "external" IGP mask file you want to use. The location of this file can be any folder on your C50r SimGEN Host or SimGEN Controller.<br>The text "Linked" shows SimGEN links the file shown to the scenario.<br>Click **Import** to navigate to a IGP mask file, as when clicking **…**<br>However, when you click **Open** in the dialog and select a file, SimGEN will import this file into the same folder as the file referencing it. This may be a scenario file (**.scn*) or the 'shared' folder; but, it is more likely to be a scenario source file, such as the signal sources file (**.qz*) here. SimGEN automatically updates the path to the file.<br>The text "Importing" shows SimGEN will import the IGP mask file you select, rather than referencing the file from its original location.<br>Notice SimGEN completes the import of the file when you click **OK** and save the new signal sources file to a name of your choice.<br>Subsequently, when you open this signal sources file, the IGP mask file you selected appears in the text area without a pathname, since it is present in the scenario folder.<br>The text "Linked" shows SimGEN links the file shown to the scenario. | | |
| **TGP mask file** | Select the file defining the locations of the valid points in the Tropospheric Grid Mask.<br>***SAIF Navigation Data - Tropo grid-point format*** (page 13-7) defines this grid-point format.<br><br>Click **…** to navigate to an "external" TGP mask file you want to use. The location of this file can be any folder on your C50r SimGEN Host or SimGEN Controller.<br>The text "Linked" shows SimGEN links the file shown to the scenario.<br>Click **Import** to navigate to a TGP mask file, as when clicking **…**<br>However, when you click **Open** in the dialog and select a file, SimGEN will import this file into the same folder as the file referencing it. This may be a scenario file (**.scn*) or the 'shared' folder; but, it is more likely to be a scenario source file, such as the signal sources file (**.qz*) here. SimGEN automatically updates the path to the file.<br>The text "Importing" shows SimGEN will import the TGP mask file you select, rather than referencing the file from its original location.<br>Notice SimGEN completes the import of the file when you click **OK** and save the new signal sources file to a name of your choice.<br>Subsequently, when you open this signal sources file, the TGP mask file you selected appears in the text area without a pathname, since it is present in the scenario folder.<br>The text "Linked" shows SimGEN links the file shown to the scenario. | | |

#### 13.6.1.1 SAIF Navigation Data - Iono grid-point format

***Notes**:*

***1)** SimGEN validates the Iono grid points in your IGP mask file and rejects bands and / or locations that do not correspond to valid Quasi-Zenith IGP values*

***2)** Spirent's default IGP mask file defines a random selection of points so that SimGEN can provide default Ionospheric correction messages. As real IGP locations are used, you can update these points with more realistic*


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*data. If you modify the default file, or create your own IGP mask file, Spirent recommends you retain the default file and rename the new file*

***3)** If SimGEN cannot open or locate an IGP mask file, it cannot broadcast Ionospheric correction messages and gives an error message*

***4)** Currently, SimGEN only supports IGP mask pattern type 1*

The Quasi-Zenith ionospheric grid-point mask (IGP Mask, MT18) defines the grid locations providing ionospheric correction information. A user-defined text file (default location *C:\Program Files\Spirent Communications\Positioning Application\QZ files\iono grid points.txt*) contains the valid grid points that SimGEN will use, disabling all other grid points. Each line of the file specifies the grid-point attributes as follows:

Band_number (integer, 0 to 9) longitude (float) latitude (float)

Where:

"!" at the start of a line indicates a comment.
A single space separates the grid-point parameters.

Example listing:

```
! Enable 4 locations in band 1
1 125.0 30.0
1 125.0 35.0
1 125.0 40.0
1 125.0 45.0
! Enable 3 locations in band 2
2 130.0 15.0
2 130.0 20.0
2 130.0 25.0
```

#### 13.6.1.2 SAIF Navigation Data - Tropo grid-point format

***Notes**:*

***1)** SimGEN does not validate the Tropospheric grid points you provide and uses the locations directly.*

***2)** Spirent's default TGP mask file defines a random selection of points so that SimGEN can provide default Tropospheric correction messages. You can update these points with a more realistic set of data when you know actual TGP locations. If you modify the default file, or create your own TGP mask file, Spirent recommends you retain the default file and rename the new file.*

***3)** If SimGEN cannot open or locate a TGP mask file, it cannot broadcast Tropospheric correction messages and gives an error message.*

***4)** The TGP mask file defines the location of each Tropospheric grid-point and must agree with the corresponding information in reference q).*

The Quasi-Zenith tropospheric grid-point mask (TGP Mask, MT52) defines the grid locations providing tropospheric correction information. A user-defined text file (default location *C:\Program Files\Spirent Communications\Positioning Application\QZ files\tropo grid points.txt*) contains the valid grid points that SimGEN will use, disabling all other grid points. Each line of the file specifies the grid-point attributes as follows:

TGP_number (integer, range 1 to 210) longitude (float) latitude (float)

Where:

"!" at the start of a line indicates a comment.
A single space separates the grid-point parameters.

Example listing:

```
! TGP mask definition
1 144.5 44.0
2 144.5 43.5
27 140.5 37.0
28 140.5 38.0
30 140.5 36.0
31 140.5 37.0
32 140.5 38.0
.
.
.
```


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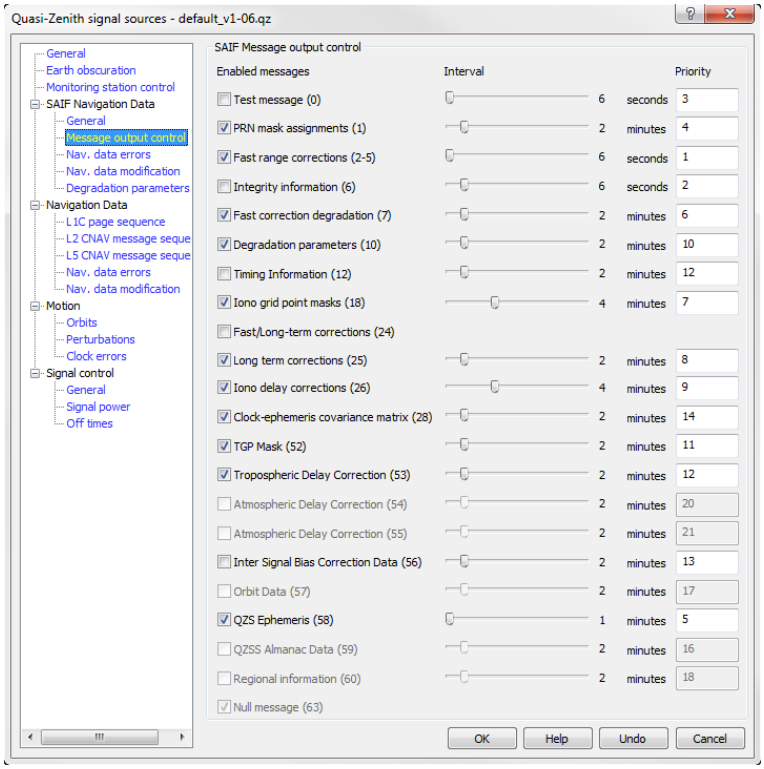
## 13.6.2 SAIF Navigation Data - Message output control

***Notes** when specifying message repetition rates:*

***1)** If the rates are too fast, there may be insufficient time to broadcast all of the messages at their required intervals. In this case, SimGEN reports an error and halts the run.*

***2)** Large amounts of data included in some message types can cause message congestion. For example, if you enable all Ionospheric grid points and all bands.*

Use the dialog below to select the SAIF messages for SimGEN to broadcast and select the nominal message **Interval** and its priority.




When you schedule several messages for transmission at the same time, **Priority** determines the message SimGEN broadcasts, this ensures messages with short time intervals have precedence.

Select the messages you want to enable, the dialog above shows the default selections.

Use the **Message output control-Interval** sliders to set the message broadcast interval, the figure to the right of the slider gives the interval in seconds or minutes.

The message intervals define the nominal time between the start of successive sequences for the given message type. The figure above shows the default priorities, with the table below showing message types and their default priorities. Change the message **Priority** by typing a new priority number in **Priority**.

***Note**: This table excludes the Mixed Corrections message (type 24) as it does not have a defined message output interval. This message type is only applicable when a scheduled, fast corrections message would be less than half-full. In this case, if long-term correction data is also pending at this time, SimGEN adds it to the fast correction data to give a Mixed message. You can disable Mixed messages if you do not require them.*

| Message type | Priority | Message type | Priority |
|---|---|---|---|
| Fast corrections | 1 | Iono delay corrections | 9 |
| Integrity Data | 2 | Degradation Parameters | 10 |
| Test message (type 0) | 3 | TGP Mask | 11 |
| PRN mask | 4 | Tropo delay corrections | 12 |
| Quasi-Zenith ephemeris | 5 | Inter-signal bias | 13 |
| Fast Correction Degradation | 6 | Covariance matrix | 14 |


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| Message type | Priority | Message type | Priority |
|---|---|---|---|
| Iono Grid Mask | 7 | Timing information | 15 |
| Long Term corrections | 8 | | |

SimGEN may interleave a low-priority message (requiring a number of message slots to complete its sequence) with other (higher priority) messages before it completes full transmission.

SimGEN always selects **Null message**, which inserts a null message into the navigation data stream if no other message is scheduled.

#### 13.6.2.1 Definition of Quasi-Zenith correction data

***Note**: Apart from the following terms, SimGEN does not use any other simulated sources of error in the satellite signals to determine correction data (for example, user-defined pseudorange ramp is not applicable).*

The broadcast Quasi-Zenith messages contain fast and long-term correction data that allow the receiver to correct for un-modelled errors in satellite pseudorange, orbit and clock.

SimGEN allows you to define errors in the simulated signals, with appropriate correction data broadcast by the Quasi-Zenith satellites. SimGEN does not try to implement an algorithm for optimising the errors in the GPS satellite signals, as perceived by the ground station network. SimGEN assigns the corrections directly from known causes of error that you can define using the ***GPS constellation editor*** (page 10-1). The following relationships then apply:

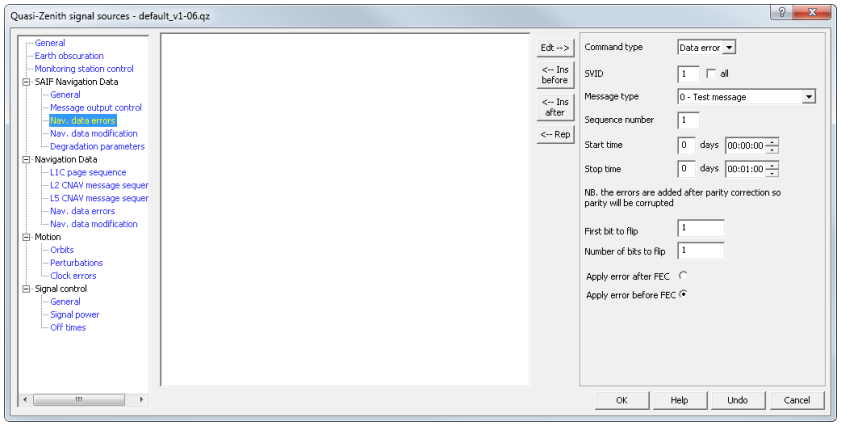
- Fast correction data is defined for those GPS satellites "visible" to the specified network of ground stations. SimGEN sets satellites in the PRN mask not seen by at least one ground station as "not monitored".
  Correction data is determined from errors in the satellite clock specified by the clock noise model (ISCN) in the GPS Constellation file (or SA if applicable). The correction data will normally be precise and should allow complete removal of the error.

- Long-term correction data is only determined for GPS satellites that are "visible" to the specified ground stations. The satellite positional error data in this message is determined from any track error defined for this satellite in the GPS Constellation file.
  The GPS Constellation file also allows this message to define clock errors for individual satellites using the **Delta af0, af1, af2** parameters.
  SimGEN only generates a Velocity Code 1 message type if the scaled values for rate of change of positional error, or the clock correction rate, are greater than zero. SimGEN does not generate long-term correction messages for the transmitting Quasi-Zenith satellite or any other Quasi-Zenith satellites of the same type.

### 13.6.3 SAIF Navigation Data - Nav data errors

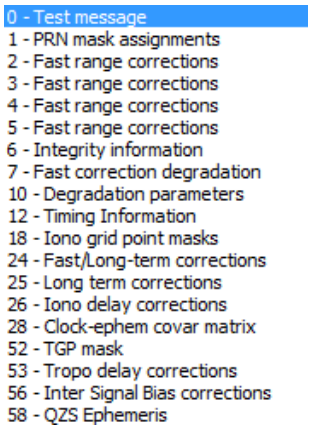
***Note**: SimGEN calculates message parity before applying these errors, so it transmits Navigation data with incorrect parity. This lets you test a receiver's error detection and correction algorithms.*

Use this dialog to insert errors into the navigation data message transmitted by one or more satellites.




| Command type | Data error | |
|---|---|---|

| | | | |
|---|---|---|---|
| **SVID** | Type the SVID you want to use or select **All** | | Range: 1 to 8 |
| **Message type** | Select from those shown in the figure below.<br>The default is **0 - Test message**. | | |
| **Sequence number** | Type the **Sequence number** you want to use<br>Default = 1 | | Range 1 to 99 |
| **Start time**<br>**Stop time** | Units:<br>d hh:mm:ss | Range:<br>0 days 00:00:00<br>to 23 days 23:59:59 | **Start** default:<br>0 days 00:00:00 (start of run)<br>**Stop** default:<br>0 days 00:01:00 |
| **First bit to flip** | This depends when you apply the error:<br>Error after FEC: Type the first symbol of the 500 broadcast symbols to invert (flip)<br>Error before FEC: Type the first bit of the 250-bit message to invert (flip) | | |
| **Number of bits to flip** | Type the number of bits (or symbols) in the message to invert (flip) | | |
| **Apply error after FEC** | Select to apply the error after SimGEN generates the symbol stream | | |
| **Apply error before FEC** | (default) Select to apply the error before SimGEN generates the symbol stream - the CRC is invalid | | |



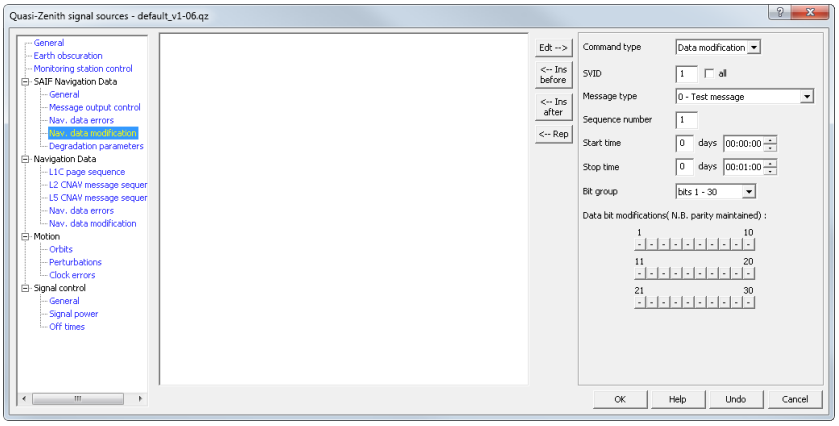

### 13.6.4 SAIF Navigation Data - Nav. data modification

***Note**: Spirent recommends you use **Nav. data modification** with caution*

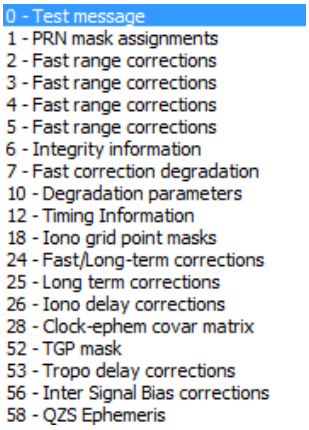
Read the following before you apply **Nav. data modification**:

- You must exercise care when modifying Quasi-Zenith Navigation messages. The contents of different messages are often inter-related and SimGEN applies any changes without amending related information in other messages. Consequently, related information can become invalid. For example, if you change the satellite mask data in message type 1 from data SimGEN generates. In most cases, data broadcast in subsequent fast correction messages will no longer be valid as it relates to the satellite list defined by the previous PRN mask. Similarly, this affects long-term correction data.
- Before changing the Quasi-Zenith Navigation message, Spirent recommends you run the relevant scenario and extract navigation data using one of the **SimGEN utilities-*Quasi-Zenith utilities*** (page 26-54). From this data, you can determine the message sequence number where this is likely to exceed one.
- Verify the validity of any changes by decoding the navigation data for the run with the changes applied.


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| | | | |
|---|---|---|---|
| **Command type** | Choose from **Data modification** or **Disable message** | | |
| **SVID** | Type the SVID you want to use or select **All** | | Range: 1 to 8 |
| **Message type** | Select from those shown in the figure below.<br>The default is **0 - Test message**. | | |
| **Sequence number** | Type the **Sequence number** you want to use<br>Default = 1 | | Range 1 to 99 |
| **Start time**<br>**Stop time** | Units:<br>d hh:mm:ss | Range:<br>0 days 00:00:00<br>to 23 days 23:59:59 | **Start** default:<br>0 days 00:00:00 (start of run)<br>**Stop** default:<br>0 days 00:01:00 |
| **Bit group** | Choose the **Bit group** you want to modify from the drop-down list | | |
| **Data bit modification** | Modify each bit in the **Bit group** by clicking on the appropriate button. This table (page 10-16) gives details of the symbols used on button.<br>The default is “leave bit as is”<br>These modifications maintain parity | | |



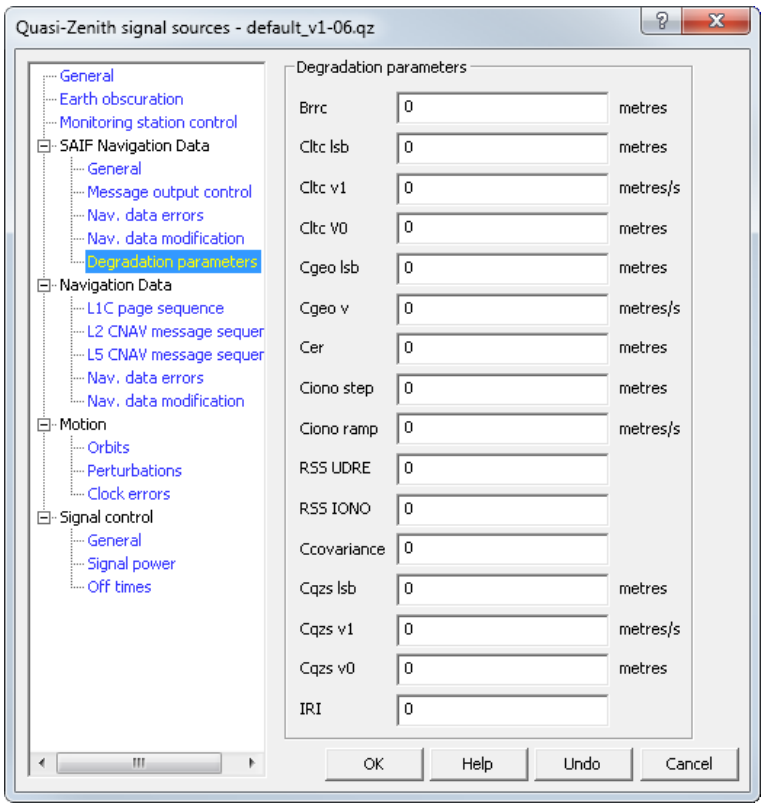

### 13.6.5 SAIF Navigation Data - Degradation parameters

***Note:*** *The output intervals specified for the relevant message types (see* ***SAIF Navigation Data - Message output control*** *(page 13-8)) determine the message update intervals (Iltc_v1, Iltc_V0, Igeo, and Iiono).*

Reference q) describes the degradation parameters that SimGEN transmits in Message Type 10.

SimGEN uses the values you enter in this dialog, see below, to generate this message.


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SimGEN fixes these parameters throughout the run and they are the same for all Quasi-Zenith satellites. Reference q) gives further details on these parameters:

| | | | |
|---|---|---|---|
| **Brrc** | Units: metres | Range: 0 to 2.046 m | Default: 0 |
| **Cltc lsb** | Units: metres | Range: 0 to 2.046 m | Default: 0 |
| **Cltc v1** | Units: metres per second | Range: 0 to 0.051 15 $m.s^{-1}$ | Default: 0 |
| **Cltc V0** | Units: metres | Range: 0 to 2.046 m | Default: 0 |
| **Cgeo lsb** | Units: metres | Range: 0 to 0.511 5 m | Default: 0 |
| **Cgeo v** | Units: metres per second | Range: 0 to 0.0511 5 $m.s^{-1}$ | Default: 0 |
| **Cer** | Units: metres | Range: 0 to 31.5 m | Default: 0 |
| **Ciono step** | Units: metres | Range: 0 to 1.023 m | Default: 0 |
| **Ciono ramp** | Units: metres per second | Range: 0 to 0.005 115 $m.s^{-1}$ | Default: 0 |
| **RSS UDRE** | Units: none | Range: 0 to 1 | Default: 0 |
| **RSS IONO** | Units: none | Range: 0 to1 | Default: 0 |
| **Ccovariance** | Units: none | Range: 0 to 12.7 | Default: 0 |
| **Cqzs lsb** | Units: metres | Range: 0 to 2.406 m | Default: 0 |
| **Cqzs v1** | Units: metres per second | Range: 0 to 0.005 115 $m.s^{-1}$ | Default: 0 |
| **Cqzs v0** | Units: metres | Range: 0 to 2.406 m | Default: 0 |
| **IRI** | Units: none | Range: 0 to 4 | Default: 0 |

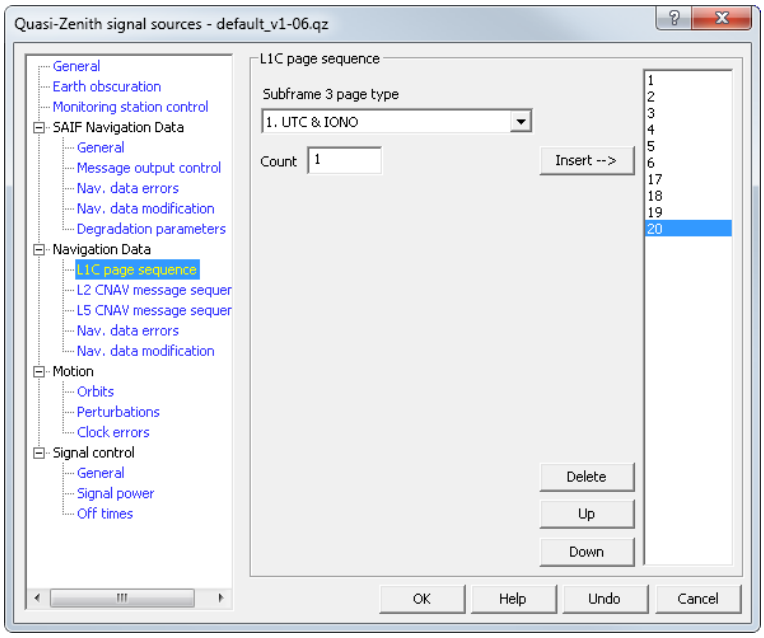

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# 13.7 Navigation Data

The following sections detail settings for Quasi-Zenith Navigation Data.

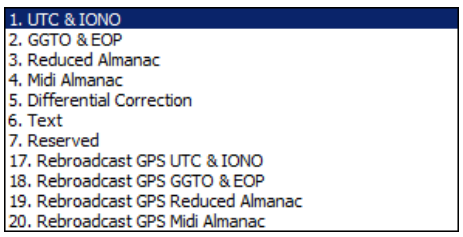
## 13.7.1 Navigation Data - L1C page sequence

Each Quasi-Zenith L1C message consists of three subframes. The first two subframes use a fixed format but you can change the content of the third subframe, using different page types and selecting the sequence of page transmission, as shown below.




The area on the right shows the page types in sequence of transmission, from top-to-bottom. You can select different **page type**s to insert in the list and change the position in the list of any **page type** shown, or **Delete** a message from the list.

| | | |
|---|---|---|
| **Subframe 3 page type** | Select from those shown in the figure below. The default is **1. UTC & IONO** | |
| **Count** | Type the number of times you want to enter the **Message type**<br>Default = 1 | Range 1 to 100 |
| **Insert →** | Default) Click to insert the **page type** at the bottom of the list;<br>or below the **page type** you select in the list | |
| **Delete** | Click to delete the selected message type | |
| **Up**, **Down** | Click to move the selected message type up or down the list | |



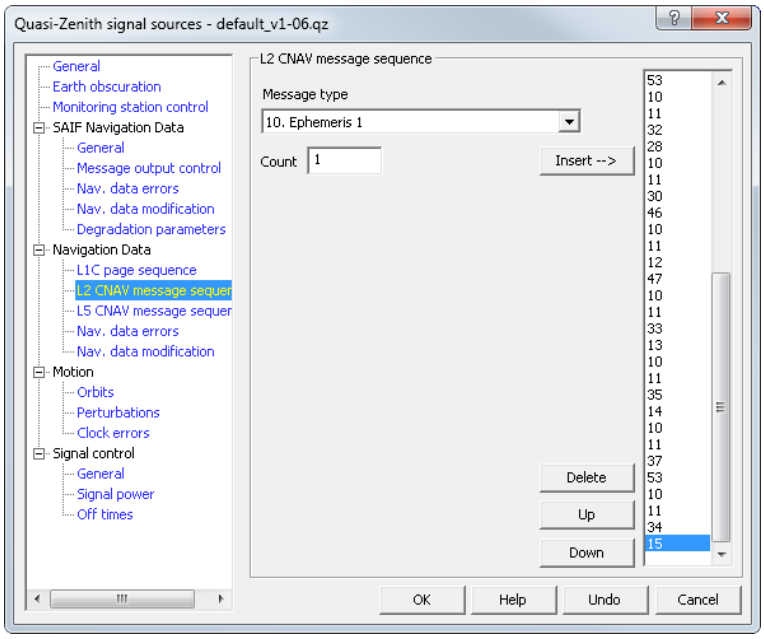


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## 13.7.2 Navigation Data - L2 CNAV and L5 CNAV message sequence

Quasi-Zenith L2C and L5 use the same dialog to enter L2 CNAV and L5 CNAV message sequences and apply Navigation data errors and modifications. This document describes the L2C dialog.

This figure shows the **L2 CNAV message sequence** dialog:




The area on the right shows the message types in sequence of transmission, from top-to-bottom. By default, SimGEN enters one of each message type, in the order shown. You can select different **Message type**s to insert in the list and change the position in the list of any **Message type** shown, or **Delete** a message from the list.

| | | |
|---|---|---|
| **Message type** | Select from those shown in the figure below.. The default is **10 - Ephemeris 1** | |
| **Count** | Type the number of times you want to enter the **Message type**<br>Default = 1 | Range 1 to 100 |
| **Insert -->** | Click to insert the **Message type** at the bottom of the list (default);<br>or below the **Message type** you select in the list | |
| **Delete** | Click to delete the selected message type | |
| **Up**, **Down** | Click to move the selected message type up or down the list | |

10. Ephemeris 1
11. Ephemeris 2
12. Reduced Almanac
13. Clock Differential Correction
14. Ephemeris Differential Correction
15. Free Text
28. Rebroadcast GPS Reduced Almanac
30. Clock, IONO and Group Delay
31. Clock & Reduced Almanac
32. Clock & EOP
33. Clock & UTC
34. Clock & Differential Correction
35. Clock & GGTO
37. Clock & Midi Almanac
46. Clock & Rebroadcast GPS IONO
47. Clock & Rebroadcast GPS Reduced Almanac
49. Clock & Rebroadcast GPS UTC
51. Clock & Rebroadcast GPS GGTO
53. Clock & Rebroadcast GPS Midi Almanac


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## 13.7.3 Navigation data errors

***Notes**:*

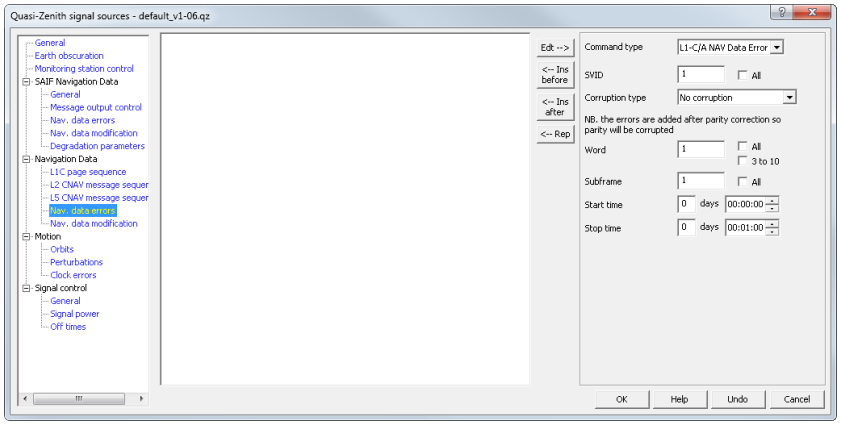
***1)** SimGEN calculates parity BEFORE making the changes, so SimGEN transmits data with incorrect parity. This tests the error detection and correction algorithms of your receiver. You can apply errors before or after FEC.*

***2)** To see the Help file topic on Navigation data errors for this constellation, Spirent recommend you select the Help topic from the **SimGEN Help-Contents** tab; clicking **Help** or pressing F1 on your keyboard may display an invalid Help topic.*

The following sections describe inserting Quasi-Zenith navigation data errors.

### 13.7.3.1 Navigation data errors - L1-C/A

Insert Quasi-Zenith L1-C/A navigation data errors using this dialog:

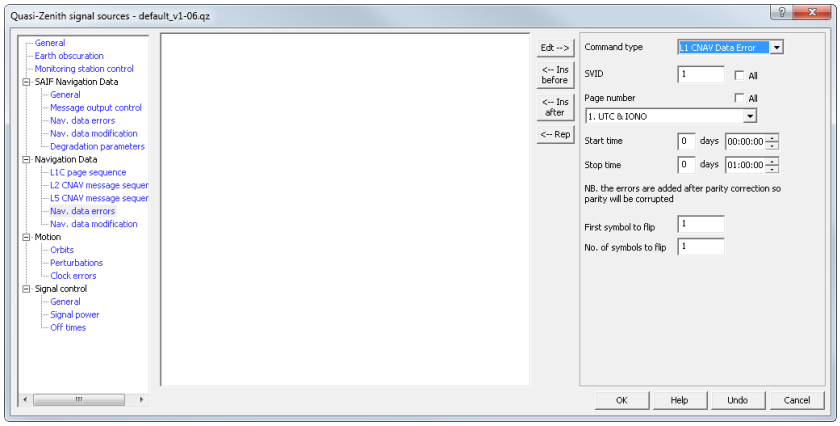



| | | | |
|---|---|---|---|
| **Command type** | **L1 C/A NAV Data Error** | | |
| **SVID** | Type the SVID you want to use or select **All** | | |
| **Corruption type** | Choose from: **No corruption** or: | | |
| **Set all zero** | Sets all bits of **Word** to zero, including parity bits | | |
| **Set word alternate 0 and 1** | Including parity bits | | |
| **Word** | Type the Word in the subframe you want to modify, or select **All** or **3 to 10** | | |
| | Units: none | Range: 1 to 10 | Default: 1 |
| **Subframe** | Type the subframe you want to modify or select **All** | | |
| | Units: none | Range: 1 to 5 | Default: 1 |
| **Start time**<br>**Stop time** | Units:<br>d hh:mm:ss | Range:<br>0 days 00:00:00<br>to 23 days 23:59:59 | **Start** default:<br>0 days 00:00:00 (start of run)<br>**Stop** default:<br>0 days 00:01:00 |


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### 13.7.3.2 Navigation data errors - L1C

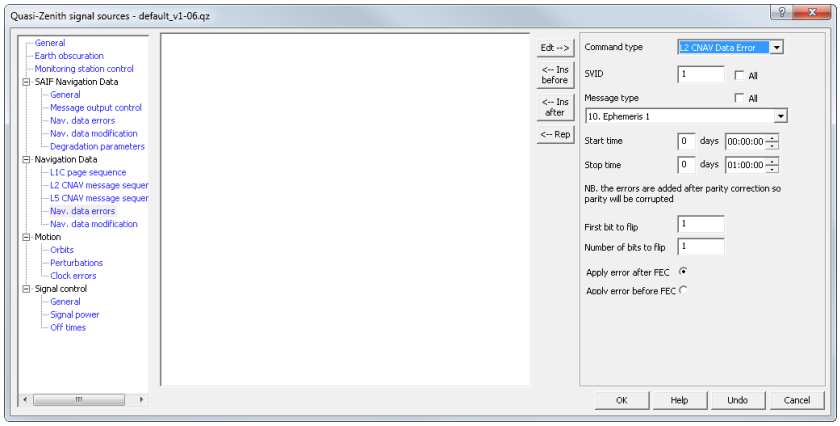
Insert Quasi-Zenith L1C navigation data errors using this dialog:




| | | | |
|---|---|---|---|
| **Command type** | **L1C Data Error** | | |
| **SVID** | Type the SVID you want to use or select **All** | | |
| **Page number** | Type the page number or select **All** | | |
| **Start time**<br>**Stop time** | Units:<br>d hh:mm:ss | Range:<br>0 days 00:00:00<br>to 23 days 23:59:59 | **Start** default:<br>0 days 00:00:00 (start of run)<br>**Stop** default:<br>0 days 01:00:00 |
| **First symbol to flip** | Select or type the first symbol to flip (invert) | | Range: 1 to 1 800 |
| **No. of symbols to flip** | Select or type the number of symbols to flip (invert) | | Range: 1 to 1 800 |

### 13.7.3.3 Navigation data errors - L2-C and L5-C

Insert Quasi-Zenith L2-C and L5-C navigation data errors using this dialog:




| | | | |
|---|---|---|---|
| **Command type** | Select from: **L2 CNAV Data Error** or **L5 CNAV Data Error** | | |
| **SVID** | Type the SVID you want to use or select **All** | | |
| **Message type** | Type the message number or select **All** | | |
| **Start time**<br>**Stop time** | Units:<br>d hh:mm:ss | Range:<br>0 days 00:00:00<br>to 23 days 23:59:59 | **Start** default:<br>0 days 00:00:00 (start of run)<br>**Stop** default:<br>0 days 01:00:00 |


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| | |
|---|---|
| **First bit to flip** | This depends when you apply the error:<br>Error after FEC: Type the first symbol of the 600 broadcast symbols to invert (flip)<br>Error before FEC: Type the first bit of the 300-bit message to invert (flip) |
| **Number of bits to flip** | Type the number of bits (or symbols) in the message to invert (flip) |
| **Apply error after FEC** | (default) Select to apply the error after SimGEN generates the symbol stream |
| **Apply error before FEC** | Select to apply the error before SimGEN generates the symbol stream - the CRC is invalid |

## 13.7.4 Nav. data modification

***Notes**:*

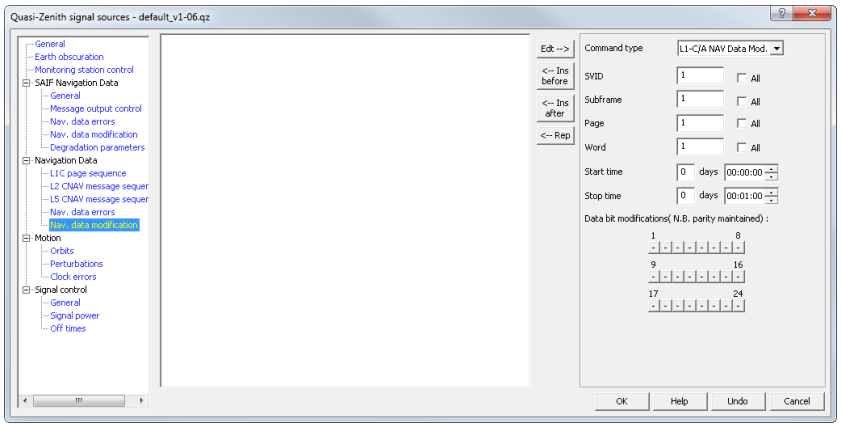
***1)** Spirent recommends you use **Navigation data modification** with caution*

***2)** To see the Help file topic on Navigation data modification for this constellation, Spirent recommend you select the Help topic from the **SimGEN Help-Contents** tab; clicking **Help** or pressing F1 on your keyboard may display an invalid Help topic.*

The following sections describe modifying the Quasi-Zenith navigation data messages.

### 13.7.4.1 Nav. data modification - L1C/A

Modify the Quasi-Zenith L1-C/A navigation data messages using this dialog:




| | | | |
|---|---|---|---|
| **Command type** | **L1-C/A Nav Data mod** | | |
| **SVID** | Type the SVID you want to use, or select **All** | | |
| **Subframe** | Type the subframe you want to modify, or select **All** | | |
| | Units: none | Range: 1 to 5 | Default: 1 |
| **Page** | Type the page you want to modify, or select **All** | | |
| | Units: none | Range: 1 to 30 | Default: 1 |
| **Word** | Type the Word you want to modify, or select **All** | | |
| | Units: none | Range: 1 to 10 | Default: 1 |
| **Start time**<br>**Stop time** | Units:<br>d hh:mm:ss | Range:<br>0 days 00:00:00<br>to 23 days 23:59:59 | **Start** default:<br>0 days 00:00:00 (start of run)<br>**Stop** default:<br>0 days 00:01:00 |

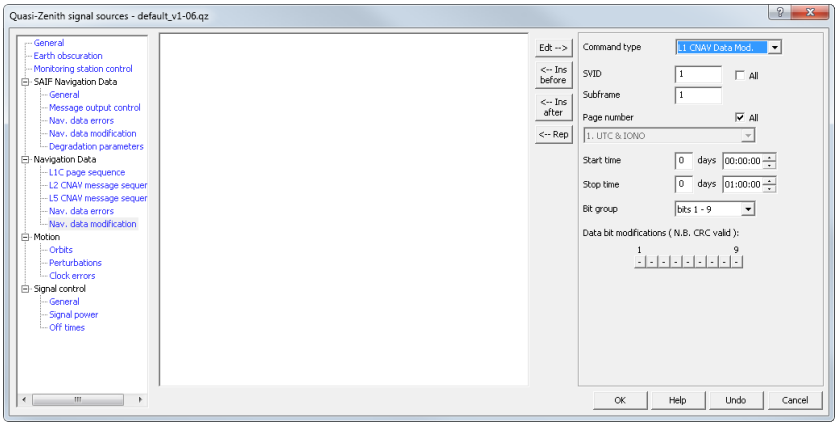

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| | |
|---|---|
| **Data bit modification** | Navigation Data words for L1C/A have 30 bits.<br>Modify non-parity bits 1 to 24 using these buttons. This table (page 10-16) details the symbols on each button.<br>The default is “leave bit as is”<br><br>Bits 25 to 30 are parity bits, which SimGEN maintains and you cannot edit |

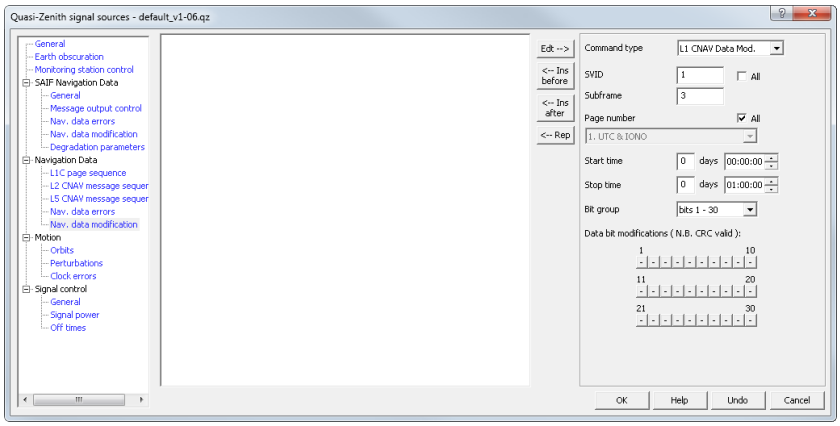
After selecting **Command type-L1-C/A NAV Data Mod**, depending on the **Subframe** you select SimGEN displays a message in the **System Messages** window to remind you this **Command type** applies only to a specific **Page** in a **Subframe**. If you want this **Command type** to apply to all pages, select **Page-All**. If you use the SimREMOTE version of this command - see reference qq), the same reminder also appears in the string send response area.

### 13.7.4.2 Nav. data modification - L1C

Modify the Quasi-Zenith L1C navigation data message using this dialog. This figure shows the dialog for Subframe 1, which has a limited number of bits available for modification:




This figure shows the dialog for Subframe 3 (Subframe2 is similar), which has a wide range of bits available for modification:



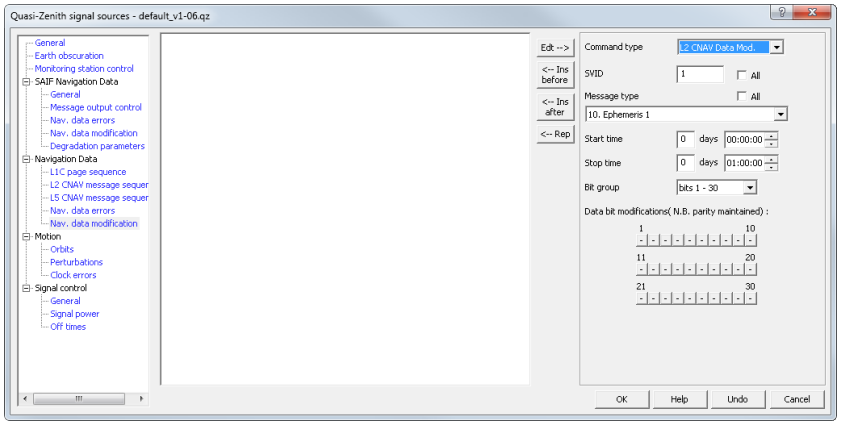

| | | | |
|---|---|---|---|
| **Command type** | **L1 CNAV Data mod** | | |
| **SVID** | Type the SVID you want to use, or select **All** | | |
| **Subframe** | Type the subframe you want to modify | | |
| | Units: none | Range: 1 to 3 | Default: 1 |


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| | | | |
|---|---|---|---|
| **Page number** | Disabled for **Subframe 1** or **2**, **All** selected by default (cannot deselect)<br>Typing **Subframe 3**: enables **Page number**, which has **All** selected by default.<br><br>To enter a specific page number, deselect **All** then select the **Page number** you want to use from:<br>1. UTC & IONO<br>2. GGTO & EOP<br>3. Reduced Almanac<br>4. Midi Almanac<br>5. Differential Correction<br>6. Text<br>7. Reserved<br>17. Rebroadcast GPS UTC & IONO<br>18. Rebroadcast GPS GGTO & EOP<br>19. Rebroadcast GPS Reduced Almanac<br>20. Rebroadcast GPS Midi Almanac | | |
| **Start time**<br>**Stop time** | Units:<br>d hh:mm:ss | Range:<br>0 days 00:00:00<br>to 23 days 23:59:59 | **Start** default:<br>0 days 00:00:00 (start of run)<br>**Stop** default:<br>0 days 00:01:00 |
| **Bit group** | You cannot modify the CRC fields (subframes 2 and 3). This gives the range of bits available for modification as:<br>**Subframe 1**: Bit 1 to 9<br>**Subframe 2**: Bit 1 to 576, in groups of 30 bits<br>**Subframe 3**: Bit 1 to 250, in groups of 30 bits | | |
| **Data bit modification** | For the **Bit group**, change the navigation data bits that SimGEN determines using these buttons. This table (page 10-16) details the symbols on each button.<br>The default is “leave bit as is” | | |

### 13.7.4.3 Nav. data modification - L2C and L5

Modify the Quasi-Zenith L2C and L5 navigation data messages using this dialog:




| | | |
|---|---|---|
| **Command type** | **L2 CNAV Data Mod** or **L5 CNAV Data Mod** | |
| **SVID** | Type the **SVID** you want to use or select **All** | Range: 1 to 8 |


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| | | | |
|---|---|---|---|
| **Message type** | To enter a specific message number deselect **All** then select the **Message type** you want to use from:<br><br>10. Ephemeris 1<br>11. Ephemeris 2<br>12. Reduced Almanac<br>13. Clock Differential Correction<br>14. Ephemeris Differential Correction<br>15. Free Text<br>28. Rebroadcast GPS Reduced Almanac<br>30. Clock, IONO and Group Delay<br>31. Clock & Reduced Almanac<br>32. Clock & EOP<br>33. Clock & UTC<br>34. Clock & Differential Correction<br>35. Clock & GGTO<br>37. Clock & Midi Almanac<br>46. Clock & Rebroadcast GPS IONO<br>47. Clock & Rebroadcast GPS Reduced Almanac<br>49. Clock & Rebroadcast GPS UTC<br>51. Clock & Rebroadcast GPS GGTO<br>53. Clock & Rebroadcast GPS Midi Almanac<br><br>or select **All** | | |
| **Start time**<br>**Stop time** | Units:<br>d hh:mm:ss | Range:<br>0 days 00:00:00<br>to 23 days 23:59:59 | Start default:<br>0 days 00:00:00 (start of run)<br>Stop default:<br>0 days 01:00:00 |
| **Bit group** | Choose the group of 30 bits you want to modify from the drop-down list | | |
| **Data bit modification** | Modify each bit in the Bit group by clicking on the appropriate button. This table (page 10-16) details the symbols on each button.<br>The default is “leave bit as is”<br>These modifications maintain parity | | |

## 13.8 Motion

The following sections describe how SimGEN models Quasi-Zenith satellite motion using Keplerian parameters.

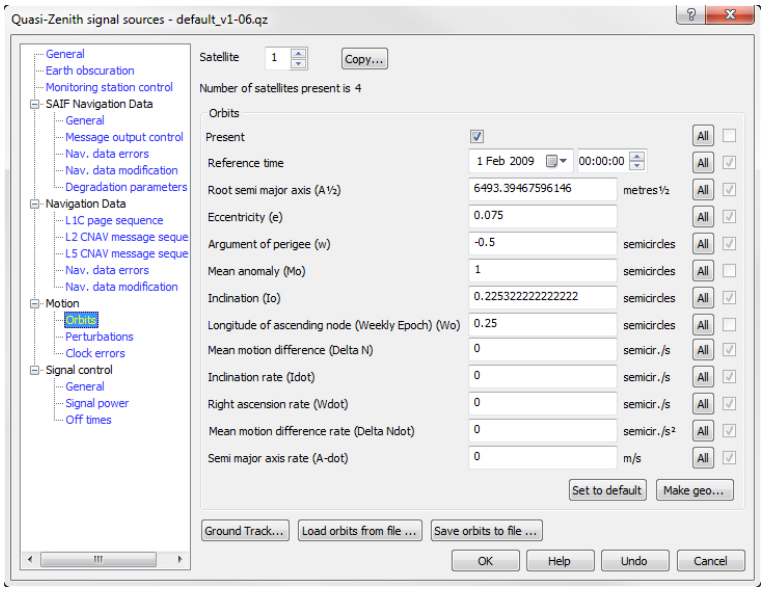
Reference a) defines the GPS terms in the dialogs and reference q) defines the Quasi-Zenith specific terms.

### 13.8.1 Motion - Orbits

***Note**: Spirent recommends you change default values with care. Unlike GPS satellites, a significant change in some parameters may move a satellite out of the Quasi-Zenith service region and effectively invalidate that satellite.*

This dialog is the same as **GPS-*Motion - Orbits*** (page 10-21), although the default values for Quasi-Zenith satellites are different.

The default values give satellite orbits that are appropriate for the Quasi-Zenith service region.





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The dialog shows the parameters for the **Satellite**. As you scroll through the satellites, using the arrow buttons on the right-hand side of **Satellite**, the orbital parameters alter accordingly.

| | | | |
|---|---|---|---|
| **Present** | Select (default): includes **Satellite** in the scenario<br>Deselect: treats **Satellite** as non-existent and does not include it in the Navigation data almanac set. | | |
| **Reference time** | This time is analogous to $t_{oe}$ in the GPS satellite data message. | | |
| | Units: d hh:mm:ss.ss | Range: 06 January 1980 00:00:00.00 to 23 January 2100 00:00:00.00 | |
| **Root semi major axis** (A½) | Units: metres$^{½}$ | Range: 2 537.0 to 6 557.0 m$^{½}$ | Default: 6493.394 675 961 46 |
| **Eccentricity (e)** | Units: none | Range: 0 to 0.2 | Default: 0.075 |
| **Argument of perigee (w)** | Units: semi-circles | Range: -1 to +1 semi-circle | Default: -0.5 |
| **Mean anomaly (Mo)** | Units: semi-circles | Range: -1 to +1 semi-circle | Default: varies with satellite number |
| **Inclination (Io)** | Units: semi-circles | Range: -1 to +1 semi-circle | Default: 0.225 322 222 222 222 |
| **Longitude of ascending node (Weekly Epoch) (Wo)** | Units: semi-circles | Range: -1 to +1 semi-circle | Default: varies with satellite number |
| ***Note**: The reference time for **Wo** is the weekly epoch at or before the orbit reference time.* | | | |
| **Mean motion difference (Delta N)** | Units: semi-circles per second | Range: -3.725 29 E-9 to +3.725 177 E-9 semicircles.s$^{-1}$ | Default: 0 |
| **Inclination rate (Idot)** | Units: semi-circles per second | Range: -9.313 227 8 E-10 to 9.312 088 9 E-10 semicircles.s$^{-1}$ | Default: 0 |
| ***Note**: When there is a large difference between **Reference Time** and the start of the scenario, use **Inclination rate** with caution. Extrapolation of the ephemeris over a long period could cause a significant change in inclination angle, so the resulting orbit is not typical of a Quasi-Zenith satellite.* | | | |
| **Right ascension rate (Wdot)** | Units: semi-circles per second | Range: -9.536 742 8 E-7 to +9.536 742 E-7 semicircles.s$^{-1}$ | Default: 0 |
| ***Note**: When there is a large difference between **Reference Time** and the start of the scenario use **Right ascension rate** with caution. Extrapolation of the ephemeris over a long period could cause a significant change in **Longitude of ascending node** so the resulting orbit is not typical of a Quasi-Zenith satellite.* | | | |
| **Mean motion difference rate (Delta Ndot)** | Units: semi-circles per (second)$^2$ | Range: ±2.273 736 754 43 E-13 semicircles.s$^{-2}$ | Default: 0 |
| **Semi major axis rate (A-dot)** | Units: metres per second | Range: -8.0 to 7.999 999 952 m.s$^{-1}$ | Default: 0 |

### 13.8.1.1 Buttons

***Note**: Currently, you can download TLE format files for the Quasi-Zenith constellation from:*
http://www.celestrak.com/NORAD/elements/sbas.txt
*You must inspect this SBAS data for the Quasi-Zenith satellite you want to use.*

*(To use this file in SimGEN, you must change its extension to *.tle)*

The buttons in the **Motion-Orbits** dialog are identical to those for GPS satellites, see **GPS-*Motion - Orbits*** (page 10-21).


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### 13.8.2 Motion - Perturbations

This dialog is the same as for the **GPS-*Motion - Perturbations*** (page 10-34), although parameter values may not be the same.

### 13.8.3 Motion - Clock errors

***Note**: Setting the **Delta Af0** clock divergence term is the same as applying a pseudorange error to that satellite.*

This dialog is the same as for the **GPS-*Motion - Clock errors*** (page 10-37), although parameter values may not be the same.

## 13.9 Signal control

Use the dialogs in the following sections to enter signal parameters for each Quasi-Zenith satellite.

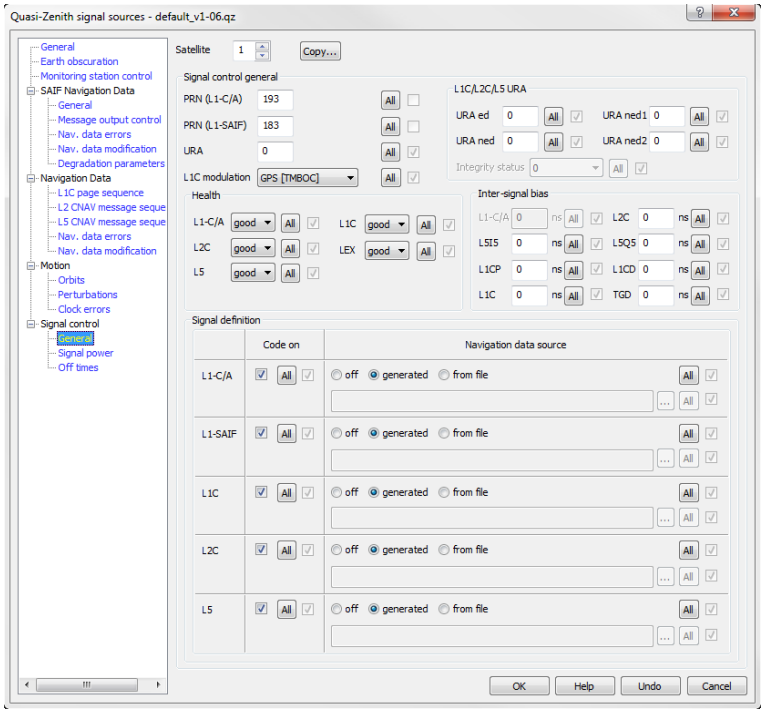
This table shows the PRN range for each Quasi-Zenith carrier.

| Signal | PRN range |
|---|---|
| L1 - SAIF | 183 (default for Satellite 1) to 192 |
| L1C/A | 193 (default for Satellite 1) to 202 |

### 13.9.1 Signal control - General

***Note**: Spirent recommends you change SimGEN's default Quasi-Zenith PRN's with caution, since SimGEN generates navigation data with respect to the satellite's SVID and not its PRN, see **Information on satellite SVID and PRN** (page 13-2).*

Use this dialog to specify characteristics of the Quasi-Zenith signal.




| | |
|---|---|
| **Satellite** | Select the Quasi-Zenith **Satellite** whose settings you want to change. |
| **Signal control general** | |


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| | | | |
|---|---|---|---|
| **PRN (L1-C/A)** and **PRN (L1-SAIF)** | The Pseudo-Random-Noise code the Satellite transmits. This table (page 13-22) gives the available Quasi-Zenith PRN ranges. SimGEN uses the values in reference q), the default values depend on Satellite.<br>For example Satellite-1 defaults:<br>L1-C/A: 193<br>L1-SAIF: 183 | | |
| **URA** | Type a value for the L1 User Range Accuracy you want the satellite to transmit | | |
| | Units: none | Range: 0 to 15 | Default: 0 |
| **L1C modulation** | Choose from: **GPS [TMBOC]** (default) or **QZS-1 [BOC(1,1)]** | | |
| **L1C/L2C/L5 URA** | Type values for the User Range Accuracy you want the **Satellite** to transmit | | |
| **URA ed**, **URA ned** | Units: none | Range: -16 to 15 | Default: 0 |
| **URA ned1**, **URA ned2** | Units: none | Range: 0 to 7 | Default: 0 |
| ***Note**: Currently **Integrity status** is disabled* | | | |
| **Health** | For each of the signals **L1-C/A**, **L2C**, **L5**, **L1C**, **LEX** choose from:<br>**good** (default)<br>**bad** | | |
| **Inter-signal bias** | | | |
| **L5I5, L1CP**, **L1C**, **L2C**, **L5Q5**, **L1CD** | Type the correction terms for group delay differences between the signal components | | |
| | Units: nanoseconds | Range: -59.64 to 59.14 ns | Default: 0 |
| ***Note**: Currently **L1-C/A** is set to 0 and you cannot change this value* | | | |
| **TGD** | Type the correction term for group delay | | |
| | Units: nanoseconds | Range: -59.64 to 59.14 ns | Default: 0 |
| ***Note**: The **Inter-signal bias** values you enter only appear in the Navigation Data message. They do not affect the RF signal from the signal generator.* | | | |
| **Signal definition** | Set the **Code** and **Navigation data source** for each of the signals **L1-C/A**, **L1-SAIF**, **L1C**, **L2C** and **L5** | | |
| **Code on** | Select (default): ranging code on<br>Deselect: ranging code off<br><br>**All** (satellites) selected by default | | |
| **Navigation data source** | For each signal choose from:<br>**off** (navigation data not broadcast)<br>**generated** (default) - by SimGEN<br>**from file**: click  and select the navigation data file.<br>The following sections give details of each file format.<br><br>**All-generated** selected by default | | |

### 13.9.1.1 L1C/A Nav data from file

***Note**: To prevent early termination of your run, you must ensure the content of the navigation data file will generate the satellite signal for the length of your simulation.*


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SimGEN can read L1C/A navigation data from a user-defined file and can read data from a separate file for each satellite.

When you create the file, you must give the time of applicability for the initial bit of the navigation data message as the first line, excluding comments (identified by a '!' at the start of the line). To ensure correct navigation data timing, the time of applicability must correspond with the scenario start time. SimGEN will report an error if the time of applicability is not the scenario start time.

The time of applicability must use this format: DD-MMM-YYYY HH:MM:SS.

Subsequent lines in the navigation data file contain navigation data for a complete subframe (as broadcast); that is, 300 bits over a six-second period. A string of 75 hexadecimal characters represents this data, where each hexadecimal character represents four bits:

"0" equates to 0000
"1" equates to 0001
"2" equates to 0010, and so on.

The first bit SimGEN broadcasts is the most significant bit of the first character, for example:

```
!Scenario start time :
16-Apr-2008 04:00:00
! Subframes of nav data
0123456789abcde0123456789abcde0123456789abcde0123456789abcde0123456789abcde
123456789abcde0123456789abcde0123456789abcde0123456789abcde0123456789abcde0
.
.
```

#### 13.9.1.2 L1-SAIF Nav data from file

Using **L1-SAIF Navigation Data from file** is similar to using **L1C/A Nav data from file**, see above.

When you create the file, you must give the time of applicability. Excluding comments (identified by a '!' at the start of the line) subsequent lines of the file consist of 125 hexadecimal characters containing 500 symbols of navigation data. These hexadecimal characters represent one second of the SAIF message, as broadcast and represent the navigation data stream after passing through the FEC encoder.

The time of applicability must use this format: DD-MMM-YYYY HH:MM:SS.

For example:

```
!Scenario start time :
10-Nov-2008 00:00:00
! 2 messages follow (each line contains 125 characters)
38763d8653fffffffff26b0000000000…....…000000000000ef1c0000000000dacbc23e5cf34
f0419d2c74ab0000000000000000..…….00daf03030d1ddf0e75740e78027438fff138bb8
```

#### 13.9.1.3 L1C Nav data from file

When you create the file, you must give the time of applicability. Excluding comments (identified by a '!' at the start of the line) subsequent lines of the file consist of 1800 symbols (450 hexadecimal characters) of navigation data per line. These hexadecimal characters represent one second of the message, as broadcast and represent the navigation data stream after passing through the FEC encoder.

The time of applicability must use this format: DD-MMM-YYYY HH:MM:SS.

For example:

```
05-Jul-2009 20:10:00
! Complete nav data messages each containing 1800 symbols, or 450 hex chars
12345678901234567890123456789O.......01234567890123456789O
11345678901234567890123456789O.......01234567890123456789O
```

#### 13.9.1.4 L2C Nav data from file

When you create the file, you must give the time of applicability. Excluding comments (identified by a '!' at the start of the line) subsequent lines of the file consist of 600 symbols (150 hexadecimal characters) of navigation data per line. These hexadecimal characters take 12 seconds to transmit and represent the navigation data stream after passing through the FEC encoder.

The time of applicability must use this format: DD-MMM-YYYY HH:MM:SS.

For example:

```
05-Jul-2009 20:10:00
! Complete nav data messages each containing 600 symbols, or 150 hex chars
```


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```
1111101234567890123456789012345678901234567890……1234567890123456789
2111101234567890123456789012345678901234567890……1234567890123456789
```

#### 13.9.1.5 L5 Nav data from file

When you create the file, you must give the time of applicability. Excluding comments (identified by a '!' at the start of the line) subsequent lines of the file consist of 600 symbols (150 hexadecimal characters) of navigation data per line. These hexadecimal characters take six seconds to transmit and represent the navigation data stream after passing through the FEC encoder.

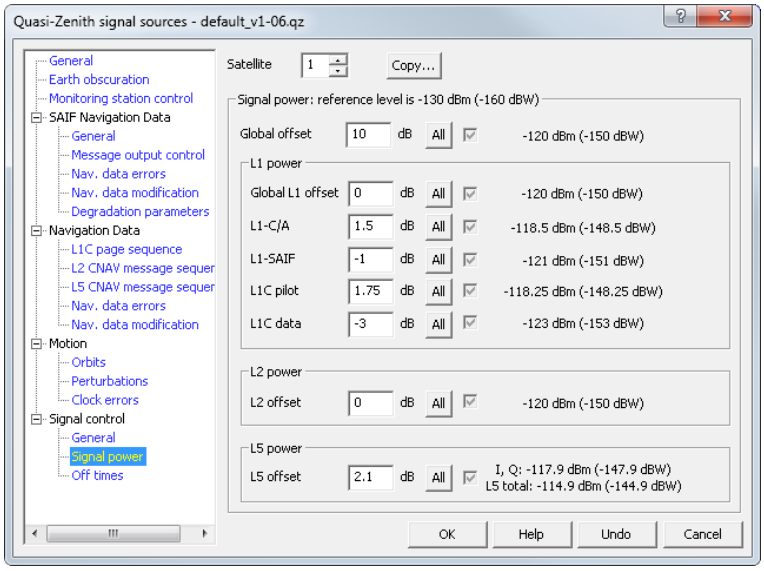
The time of applicability must use this format: DD-MMM-YYYY HH:MM:SS.

For example:

```
05-Jul-2009 20:10:00
! Complete nav data messages each containing 600 symbols, or 150 hex chars
1111101234567890123456789012345678901234567890……1234567890123456789
2111101234567890123456789012345678901234567890……1234567890123456789
```

### 13.9.2 Signal control - Signal power

Use this dialog to control the signal level characteristics of all simulated carrier frequencies at the RF output of the signal generator.




If you select ***General*** **-Signal Strength-Modelled** (page 13-3), SimGEN applies the values you enter in this dialog before performing modelling.

| | | | |
|---|---|---|---|
| **Satellite** | Select the **Satellite** whose settings you want to change. | | |
| **Signal power** | ***Note**: The power level SimGEN applies is shown to the right of **All***<br><br>Set the signal power offsets from the Quasi-Zenith reference level of -130 dBm for each signal shown | | |
| **Global offset** | Type the Global offset with respect to the reference level. | | |
| | Units: decibels | Range: - 20.0 to 20.0 dB | Default: 10 |
| **L1 power** | Type the relative power offset for each component of the L1 signal. | | |
| **Global L1 offset, L1-C/A, L1-SAIF, L1C pilot, L1C data** | Units: decibels | Range: - 20.0 to 20.0 dB | Default:<br>10 (**Global L1 offset**)<br>1.5 (**L1-C/A**)<br>-1 (**L1-SAIF**)<br>1.75 (**L1C pilot**)<br>-3 (**L1C data**) |
| **L2 power** | Type the relative power offset for the L2 signal. | | |
| | Units: decibels | Range: - 20.0 to 20.0 dB | Default: 0 |


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| | | | |
|---|---|---|---|
| **L5 power** | Type the relative power offset for the L5 signal.<br>The text on the right-hand side gives the L5 I and Q power SimGEN applies and the total L5 power. | | |
| | Units: decibels | Range: - 20.0 to 20.0 dB | Default: 2.1 |

Click **All** to apply the value of the parameter (or apply the action) to all Quasi-Zenith satellites.

### 13.9.3 Signal control - Off times

This dialog is the same as **GPS-*Signal Control - Off times*** (page 10-50)


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# 14 SBAS constellation editor

***Notes**:*

***1)** SDCM broadcasts only on GPS L1 (other SBAS system broadcast on both L1 and L5)*

***2)** You must enable GPS when you use any SBAS constellation, as all SBAS constellation run within the GPS channel group.*
*If SimGEN detects the GPS constellation is missing, it displays this message in the **System Messages** (page 3-15) window: "No GPS correction data will be broadcast in the absence of GPS satellites"*

***3)** You must enable both GPS and GLONASS when using SDCM, as this system uses data from both GLONASS and GPS satellites.*
*If SimGEN detects the GPS or GLONASS constellations are missing, it displays these messages, as appropriate, in the **System Messages** (page 3-15) window: "No GPS correction data will be broadcast in the absence of GPS satellites" or "No GLONASS correction data will be broadcast in the absence of GLONASS satellites"*

***4)** GSS7700 variant A signal generator supports SDCM; but notice the front panel screen on this signal generator displays G2 delay values instead of SDCM PRNs*

***5)** GSS9000-series, GSS8000-series, GSS7000 and GSS6700 (and the superseded GSS6560 and GSS7700 Variant B) signal generators support SDCM*

SBAS (Satellite Based Augmentation System) is the generic term for all space-based augmentation systems.

Spirent implements the following SBAS constellations in SimGEN:

- EGNOS (European Geostationary Navigation Overlay System) - Europe
- GAGAN (GPS Aided Geo Augmented Navigation) - India
- MSAS (Multi-functional Satellite Augmentation System) - Japan
- SDCM (System for Differential Corrections and Monitoring) - Russia (see Notes above)
- WAAS (Wide Area Augmentation System) - America

***Quasi-Zenith constellation editor*** (page 13-1) describes using the Quasi-Zenith constellation.

Each SBAS system uses geostationary satellites to broadcast additional ranging signals plus corrections and health information for GPS users. Spirent formats all SBAS messages according to reference d), irrespective of the specific system you use.

The GSS9000-series, GSS7000, GSS8000-series and GSS6700 (and the superseded GSS6560 and STR4760) GPS signal generators are capable of simulating EGNOS, GAGAN, MSAS and WAAS SBAS signals on any channel as an alternative to the normal GPS signal. Currently, the GSS6700 also supports simulating SDCM on GPS L1.

To use an SBAS constellation, first see **Receive and transmit antennas-*Associate a GNSS signal with an antenna*** (page 23-4) and associate the appropriate signal with the antenna(s) you want to use. The examples in this chapter describe using the WAAS signal, with additional screenshots showing details for the other constellations as appropriate.

## 14.1 SBAS constellation editor

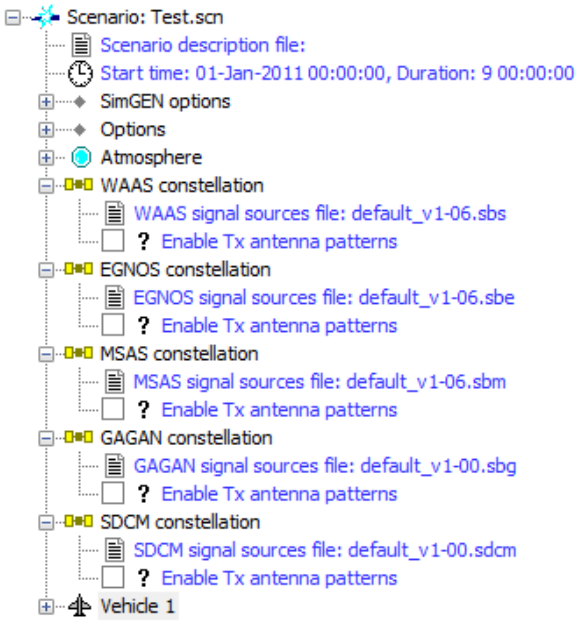
***Note**: The range of parameter values you can enter in PosApp may be different from the values commonly used in satellite navigation systems.*

Use the constellation editor to edit data in the SBAS constellation file. The editor shows the data in the SBAS constellation file as a series of "pages". The left-hand area shows the pages you can select for editing; the right-hand area shows the details of the page you selected in the left-hand area. This section describes how you select and change details in the right-hand area.

SimGEN checks the range of the value you type in a text box and, if incorrect, displays the range of acceptable values.

After associating the SBAS signal type with an antenna, the SBAS constellation file appears in the **Scenario contents** window. This figure shows all the SBAS constellations:


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**Receive and transmit antennas-*Transmitter antenna level and phase patterns*** (page 23-20) details creating and applying **Tx antenna patterns**.

Edit the SBAS constellation file in the same way as you would edit any other constellation file. First, expand the ***<SBAS constellation>***. Then:

→ Select ***<SBAS constellation>*-Signal sources file**

→ Right-click and select **Edit**

→ The SBAS Signal sources editor opens by default on ***Monitoring station control***.

→ The SBAS signal sources file has the default name *default_vx-yy* , with the extension defining the constellation, as in this table:

| Extension | Constellation |
|---|---|
| *sbe* | EGNOS |
| *sbg* | GAGAN |
| *sbm* | MSAS |
| *sbs* | WAAS |
| *sdcm* | SDCM |

→ To allow concurrent simulation of more than one SBAS constellation, each SBAS constellation has its own editor that shows the default file, *default_vx-yy*, as shown in the figure above.

The constellation editor fields are identical for each SBAS type, except the default satellite positions and associated Ground station positions for each type is geographically correct. SDCM adds parameters to some fields.

## 14.2 Monitoring station control

***Notes**:*

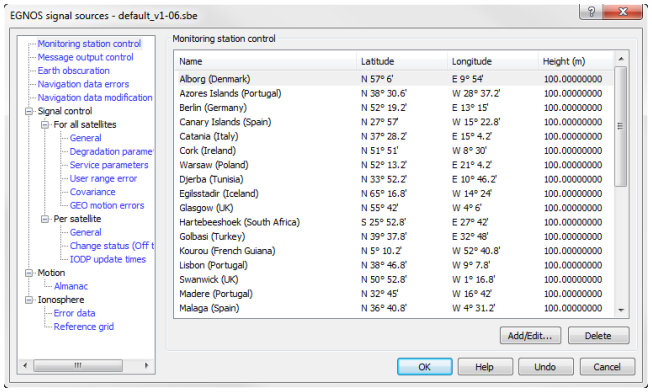
***1)** Normally, you would define at least one monitoring station in the region of the simulated vehicle(s).*

***2)** SimGEN requires line-of-sight visibility to at least four ground-monitoring stations. A message warns you if you attempt to delete the fourth ground-monitoring station.*

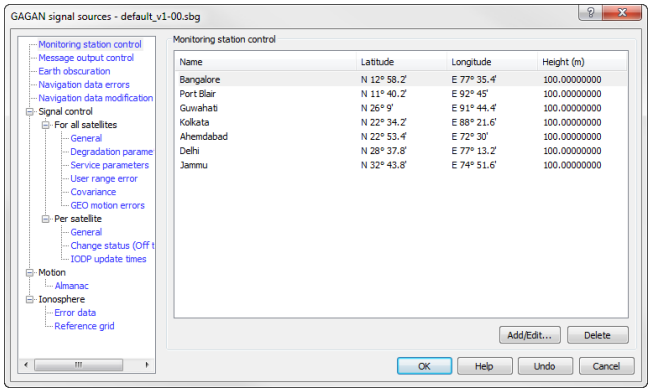
Use this dialog to enter the location of ground-monitoring stations. The dialog varies for each SBAS constellation, as shown in the following figures:


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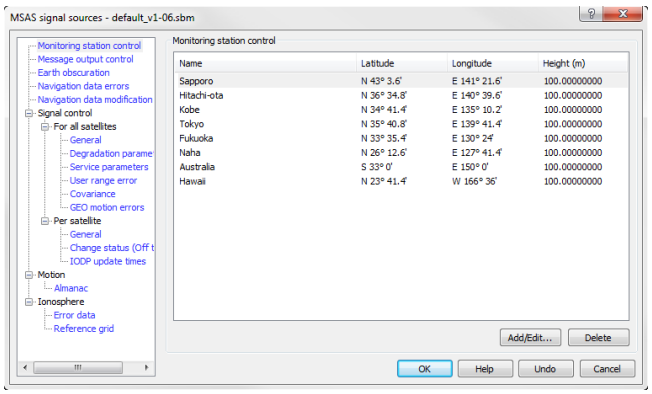
## EGNOS




## GAGAN

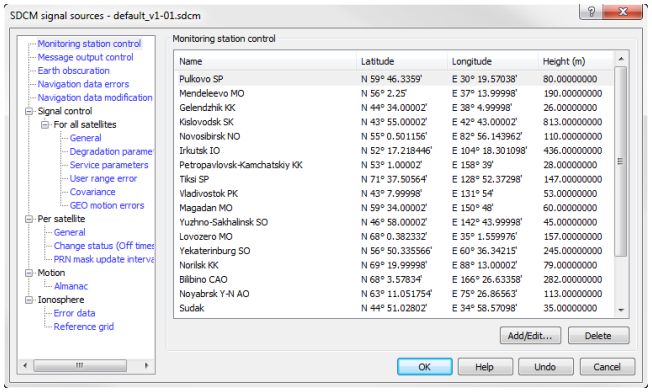



## MSAS




## SDCM

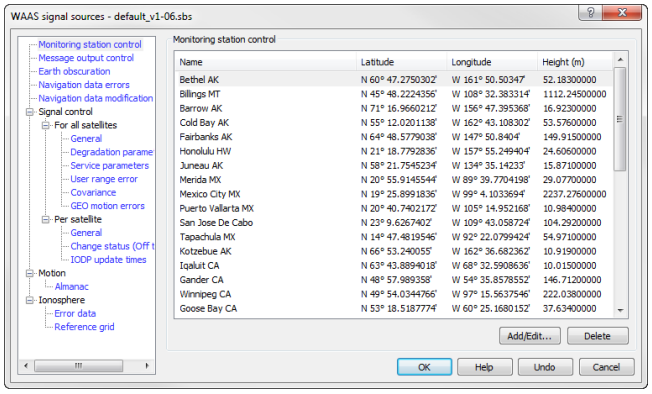
***Note**: Currently, SimGEN version 5.04 onwards supports SDCM for the GSS6700 signal generator only*





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**WAAS**



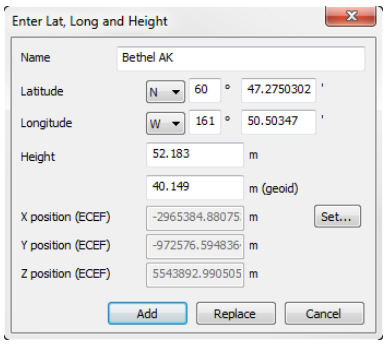

The ground station locations determine satellite visibility for the SBAS system; that is, they determine which satellites will be included in the SBAS correction messages. If you select ***Covariance*-Covariance data-user defined** (page 14-15), the visibility criterion is to accept satellites visible by direct line-of-sight to at least one monitoring station. Selecting **automatic** considers satellites with a covariance matrix within the allowed bounds for this message type, as monitored.

To enter the location of a ground station:

→ Right-click **<*SBAS constellation*>-Signal sources file**.

→ Click **Edit** to open the **Signal sources-Monitoring station control** dialog.

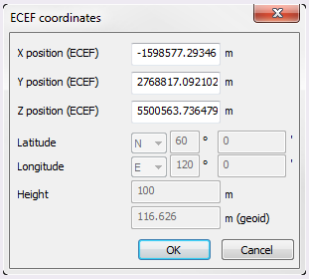
→ Click **Add/Edit…** to open the **Enter Lat, Long and Height** dialog shown below. You can enter the monitoring station location using **Latitude**, **Longitude** and **Height**, or using ECEF coordinates.




| | | | |
|---|---|---|---|
| **Name** | Type a name for the new Monitoring station | | |
| **Latitude** | Type the position of the new Monitoring station | | |
| | Units: degrees, minutes | Range: N 90° 0.0′ to S 90° 0.0′ | |
| **Longitude** | Type the position of the new Monitoring station | | |
| | Units: degrees, minutes | Range: W 180° 0.0′ to E 180° 0.0′ | |
| **Height** | Type the height of the new Monitoring station | | |
| | Units: metres | Range: -9 999 to +30 000 m | Default: 0 (-18 geoid) |


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Clicking **Set…** opens this dialog in which you can enter the reference location in **ECEF coordinates**:




Notice **Latitude**, **Longitude** and **Height** update automatically as you move between the X, Y and Z positions.

| | | |
|---|---|---|
| **X position (ECEF), Y position (ECEF), Z position (ECEF)** | Units: metres | Range: -1E10 to 1E10 m |

→ Click **OK** after completing the entries in the dialog.

To edit the data of an existing monitoring station, select the station and click **Add/Edit…**

To delete a monitoring station, select the station and click **Delete**.
Delete more than one monitoring station by selecting the monitoring stations and clicking **Delete**.

## 14.3 Message output control

***Notes**:*

***1)**: As several different message types may be due for transmission at the same time some means of message scheduling is required. Scheduling is further complicated by the fact that some of the message types may occupy only a single, one second, message block of 250 bits to broadcast all related data (for example Integrity data); whereas other message types may run over several message blocks (for example Long Term Corrections).*

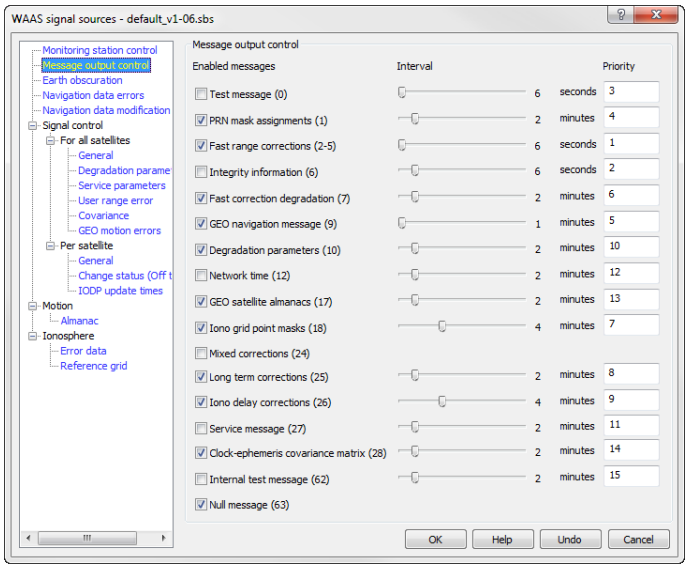
***2)**: Currently, SimGEN version 5.04 onwards supports SDCM for the GSS6700 signal generator only*

***Notes** when specifying message repetition rates:*

***1)** If the rates are too fast, there may be insufficient time to broadcast all of the messages at their required intervals. In this case, SimGEN reports an error and halts the run.*

***2)** Large amounts of data included in some message types can cause message congestion. For example, if you enable all Ionospheric grid points and all bands.*

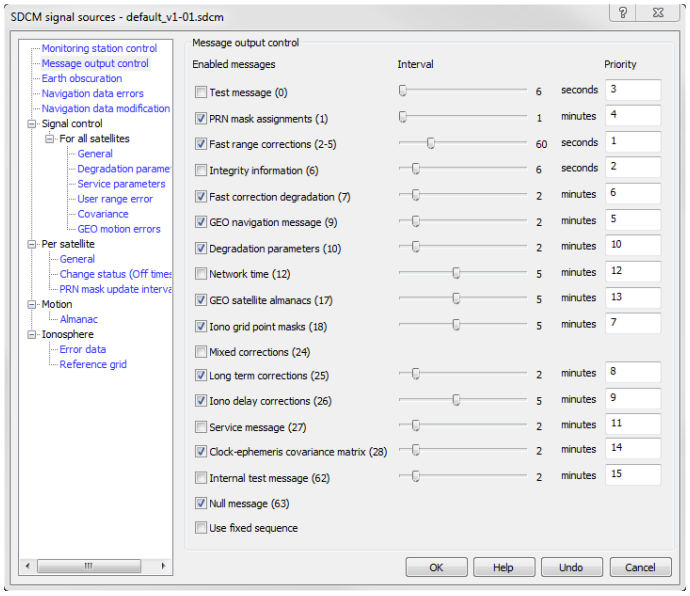
Use this dialog to enable messages, set the message interval and priority, for all satellites in a constellation. This figure shows the dialog for EGNOS, GAGAN, MSAS and WAAS:





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This figure shows the dialog for SDCM:




| | |
|---|---|
| **Use fixed sequence** (SDCM only) | Deselect (default): Use a variable message sequence<br>Select: Disables **Enabled messages**, **Interval** and **Priority** for all messages and uses a fixed message sequence.<br>SimGEN defines the fixed message sequence in the engine. The applicable message type and time of applicability depends on Annex F (with respect to the current time of week) and Annex G (the sequence starts when SimGEN uses the dynamic PRN mask update method, and after SimGEN updates the mask) of the ICD, reference dd).<br>In addition, Annex F of reference dd) allows broadcast of either MT27 or MT28 at the same time when using the fixed sequence.<br>Choose the **Broadcast message type** from:<br>**27 (SDCM Service Message)**<br>**28 (Covariance Matrix Message)** |
| ***Note**: Currently, SimGEN version 5.04 onwards supports SDCM for the GSS6700 signal generator only* | |

Select the messages you want to enable, the figures above shows the default selections.

Use the **Message output control-interval** sliders to set the message broadcast interval.

The message intervals define the nominal time between the start of successive sequences for the given message type. If more than one message type is due for transmission at any time, **Priority** determines when SimGEN broadcasts the message type. This table details the message types and their priorities.

***Note**: The following table excludes the Mixed Corrections message (type 24) as it does not define the message output interval. Message type 24 only applies when a scheduled, fast corrections message is less than half-full, then SimGEN adds pending long-term correction data to the fast correction data to give a Mixed Corrections message. You can disable Mixed messages if you do not require them.*

| Priority Order | Message type | Priority Order | Message type |
|---|---|---|---|
| **1** | Fast corrections | **9** | Iono delay data |
| **2** | Integrity Data | **10** | Degradation Parameters |
| **3** | Test message (type 0) | **11** | Covariance Matrix |
| **4** | PRN mask | **12** | WAAS Service message |
| **5** | GEO Nav Data | **13** | WAAS Network Time |
| **6** | Degradation Factors | **14** | GEO Satellite Almanacs |
| **7** | Iono Grid Mask | **15** | Internal Test message |


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| Priority Order | Message type | Priority Order | Message type |
|---|---|---|---|
| 8 | Long Term corrections | 16 | Null message |

Set the priority for the enabled message by typing the priority number in **Priority**.

SimGEN may interleave a low-priority message type (requiring a number of message slots to complete its sequence) with other (higher priority) messages before it completes full transmission.

Spirent recommends you select (default setting) **Null message**, so SimGEN inserts a null message into the navigation data stream if no other message is scheduled. If you deselect **Null message**, SimGEN fills any vacant message slot with a blank message, that is, all zeroes. You must determine whether your receiver will ignore or correctly handle these blank messages.

Spirent do not currently implement repetition of messages following an Alarm condition.

### 14.3.1 Definition of SBAS correction data

***Note**:*

***1)** Apart from the following terms, SimGEN does not use any other simulated sources of error in the satellite signals to determine the SBAS correction data (for example, user-defined pseudorange ramp or SA ephemeris offsets are not applicable).*

***2)** Currently, SimGEN does not broadcast correction data messages for GLONASS satellites.*

The broadcast SBAS messages containing fast and long-term correction data allow correction of un-modelled errors in the GPS satellite pseudorange, orbit and clock by the user's equipment.

SimGEN allows you to define errors in the simulated signals, with appropriate correction data broadcast by the SBAS satellites. SimGEN does not try to implement an algorithm for optimising the errors in the GPS satellite signals, as perceived by the ground station network. SimGEN assigns the corrections directly from known causes of error that you can define in the ***GPS constellation editor*** (page 10-1). SimGEN applies the following:

- Defining fast correction data for those satellites "visible" to the specified network of ground station and flagging those satellites in the PRN mask not seen by at least one ground station as "not monitored".
  Correction data is determined from errors in the satellite clock specified by the clock noise model (ISCN) in the GPS Constellation file (or SA if applicable). The correction data will normally be precise and should allow complete removal of the error; however, randomness could be introduced see UDREI error mode in ***General*** (page 14-9).
  ***Note**: All SBAS satellites are included in this context. See **GEO motion errors** (page 14-16).*

- Long-term correction data is only determined for satellites which are "visible" to the specified ground stations. The satellite positional error data in this message is determined from any track error defined for this satellite in the GPS Constellation file.
  The GPS Constellation file also allows this message to define clock errors for individual satellites using the Delta af0, af1, af2 parameters.
  SimGEN only generates a Velocity Code 1 message type if the scaled values for rate of change of positional error, or the clock correction rate, are greater than zero. SimGEN does not generate long-term correction messages for the transmitting SBAS satellite or any other SBAS satellites of the same type. SimGEN generates these messages for SBAS satellites of a different (foreign) type see ***GEO motion errors*** (page 14-16).

## 14.4 Earth obscuration

Use this dialog to determine how SimGEN calculates SBAS satellite obscuration by the Earth's surface; it is the same dialog as in **GPS-*Earth obscuration*** (page 10-11).

## 14.5 Navigation data errors and modification

***Notes**:*

***1)** Spirent recommends you use **Navigation data errors** and **Navigation data modification** with caution*

***2)** To see the Help file entries for this constellation, Spirent recommend you select the Help topic from the **SimGEN Help-Contents** tab; clicking **Help** or pressing F1 on your keyboard may display an invalid Help topic.*

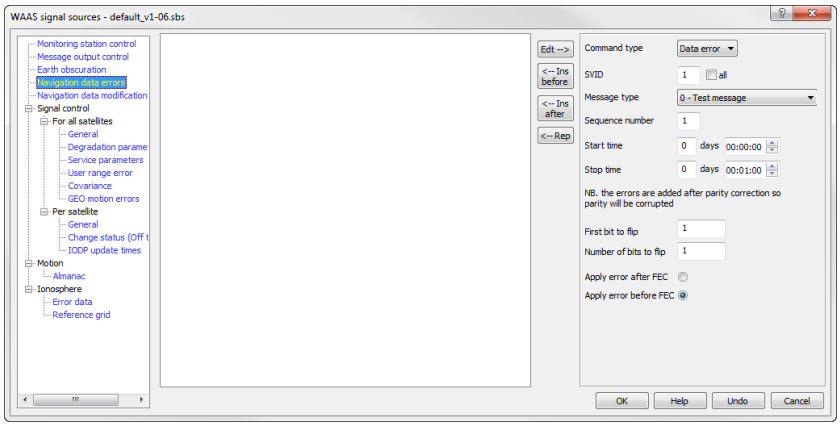
Before you apply **Navigation data errors** or **Navigation data modification** using the appropriate **Command type** in the ***List Editor*** (page 5-33):


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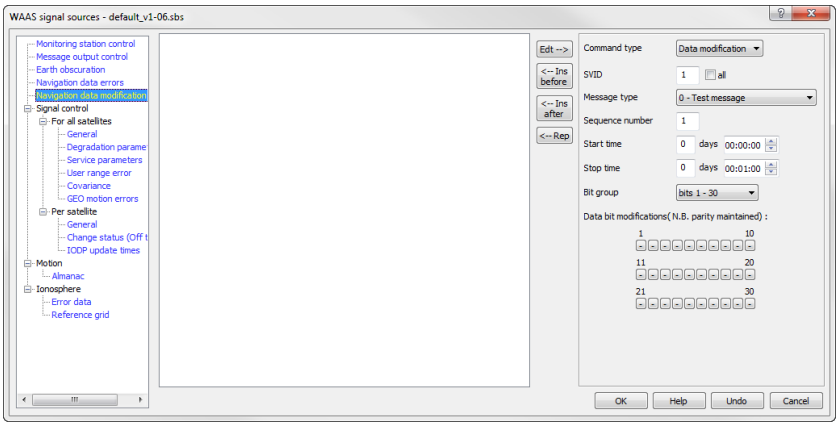
→ You must exercise care when modifying SBAS Navigation messages. The contents of different messages are often inter-related and SimGEN applies any changes without amending related information in other messages. Related information can become invalid.
For example, changing the satellite mask data in message type 1 from data SimGEN generates (say the change is to switch the status of PRN 3 and increment the IODP). In most cases, the data broadcast in subsequent fast correction messages is no longer valid as it relates to the satellite list defined by the previous PRN mask. Similarly, this affects long-term correction data.

→ Before changing the SBAS Navigation message, Spirent recommends you run the relevant scenario and use **SimGEN utilities-*SBAS Nav Data Extract*** (page 26-51) to extract logged SBAS nav data. You can then determine the message sequence number when this is likely to exceed one.
Then, verify the validity of your changes by decoding the navigation data for the run with change

**Navigation data error dialog**:

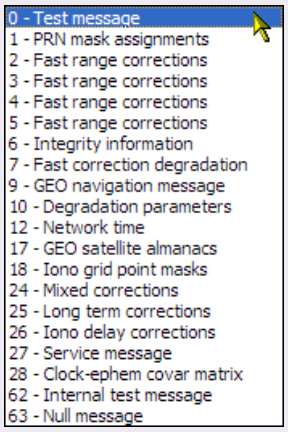



**Navigation data modification dialog**:




| | | |
|---|---|---|
| **Command type** | Choose from:<br>**Navigation data errors-Data error**<br>**Navigation data modification-Data modification**<br>**Navigation data modification-Disable message** | |
| **SVID** | Type the SVID you want to use or select **All** | Range: 1 to 5 |


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| | | | |
|---|---|---|---|
| **Message type** | Default: **0 - Test message**<br>Select from those shown below<br>  | | |
| **Sequence number** | (Default = 1) Type the **Sequence number** you want to use | Range 1 to 99 | |
| **Start time**<br>**Stop time** | Units:<br>d hh:mm:ss | Range:<br>0 days 00:00:00<br>to 23 days 23:59:59 | **Start** default:<br>0 days 00:00:00 (start of run)<br>**Stop** default:<br>0 days 00:01:00 |
| **Navigation data error parameters** | | | |
| **First bit to flip** | This depends when you apply the error:<br>Error after FEC: Type the first symbol of the 500 broadcast symbols to invert (flip) Error before FEC: Type the first bit of the 250-bit message to invert (flip) | | |
| **Number of bits to flip** | Type the number of bits (or symbols) in the message to invert (flip) | | |
| ***Note**: Before this corruption, SimGEN calculates and appends the 24 CRC bits to the data* | | | |
| **Apply error after FEC** | Select to apply the error after SimGEN generates the symbol stream | | |
| **Apply error before FEC** | (default) Select to apply the error before SimGEN generates the symbol stream - the CRC is invalid | | |
| **Navigation data modification parameters** | | | |
| **Bit group** | Choose the **Bit group** you want to modify | | |
| **Data bit modification** | (Default: - “leave bit as is”)<br>Modify the bits in the **Bit group** using the buttons. This table (page 10-16) details the symbols on each button. | | |

## 14.6 Signal control - For all satellites

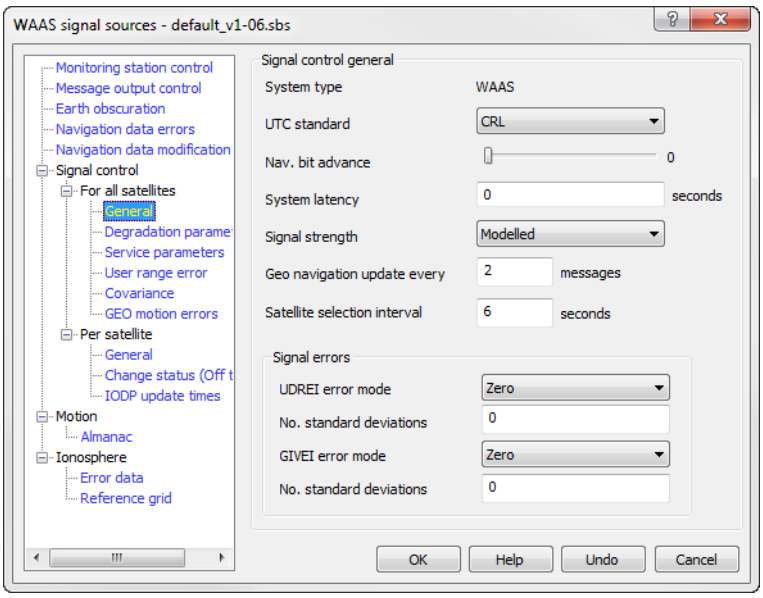
Use these pages to control the signals for all satellites. ***Signal control - Per satellite*** (page 10-16) describes the signal controls for each satellite in the SBAS constellation

### 14.6.1 General

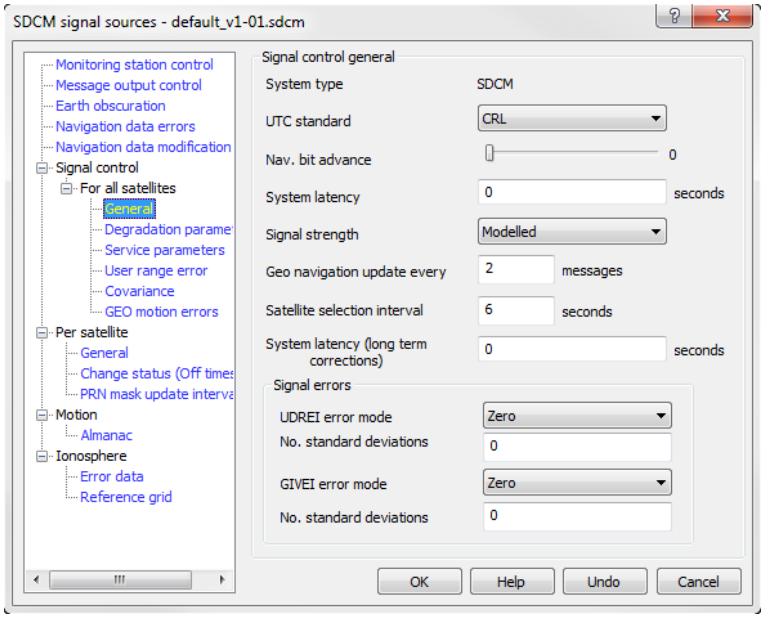
***Note**: Currently, SimGEN version 5.04 onwards supports SDCM for the GSS6700 signal generator only*

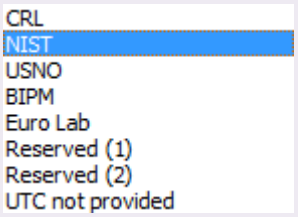
This dialog controls parameters for all SBAS satellites, **System type** gives the constellation type. This figure shows the dialog for EGNOS, GAGAN, MSAS and WAAS satellites:


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This figure shows the dialog for SDCM satellites:




| | |
|---|---|
| **System type** | Shows the Service Provider ID field in the SBAS GEO Almanacs message (type 17). Currently, there is no differentiation between the different SBAS types and the message format is the same in each case. |
| **UTC standard** | Specifies the UTC reference standard in the SBAS network time message (type 12). Choose from the items in this drop-down list:<br>  |


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| | | | |
|---|---|---|---|
| **Nav. bit advance** | Allows SimGEN to advance the SBAS data stream with respect to the SBAS Network Time (SNT).<br>The default value of zero gives the normal SBAS mode of operation, so that SimGEN:<br>1) synchronises the leading edge of the first symbol that depends on the first bit of the current message to a one second epoch in SNT (as required in reference d)).<br>2) determines the first two symbols for generation in the four millisecond period following the one second SNT epoch from the leading bit of the current message and the last six bits of the preceding message, which are held in the convolutional encoder. | | |
| | Units: none | Range: 0 to 6 | Default: 0 |
| ***Note**: Spirent provides this parameter for historical reasons.*<br>*Earlier versions of reference d) specified applying the input to the FEC algorithm seven bits early.*<br>*Selecting **Nav. bit advance = 6** resulted in generation of the leading two symbols after the one second SNT epoch from the first seven bits in the current message* | | | |
| **System latency** | In the SBAS context, the value for SBAS system latency broadcast in the Fast Correction Degradation Factor message (type 7).<br>Spirent assumes delay in determining SBAS correction data is implicit in the time of applicability of this data. | | |
| | Units: integer seconds | Range: 0 to 15 s | Default: 0 |
| **Signal strength** | Select whether SimGEN modifies satellite signal-levels based on satellite-to-antenna distance or uses a fixed signal level.<br>**GPS-*General - Modelled and fixed signal strength*** (page 10-8) gives further details on **Modelled** and **Fixed**.<br>In each case, first set the base RF power level using ***<SBAS constellation>-Signal control - Per satellite*-Power level** (page 14-18) | | |
| **Modelled** | (default) SimGEN modifies satellite signal level as a function of the satellite to receiver antenna distance in proportion to $(\text{distance})^{-2}$ | | |
| **Fixed** | SimGEN does not modify the signal level as a function of satellite to receiver antenna distance | | |
| **Geo navigation update every** | The message update rate.<br>**1** refreshes the navigation data message every time it changes.<br>**2** uses the navigation data message twice before refreshing. | | |
| | Units: messages | Range: 1 to 100 | Default: 2 |
| **Satellite selection interval** | The interval SimGEN uses to calculate which SBAS satellites to use in the run, see ***General Options*-Simulation iteration rate** (page 5-15) | | |
| | Units: seconds | Range: 1 to 600 s | Default: 6 |
| **System latency (long term corrections)** (SDCM only) | The interval starting from the last GLONASS ephemeris update to the predicted time of receiving the long-term correction | | |
| | Units: seconds | Range: 0 to 30 s | Default: 0 |
| ***Note**: Currently, SimGEN version 5.04 onwards supports SDCM for the GSS6700 signal generator only* | | | |
| **Signal errors** | | | |
| **UDREI error mode** | Generates GPS satellite clock and position errors<br>The SBAS facility includes correction data for these errors in the fast and long-term messages, with the accuracy of the fast correction data indicated by the UDREI values.<br>The broadcast UDREI values may change as the GPS satellites change position according to a grid of UDREI values you define in ***Ionosphere - Reference grid-abridged*** (page 14-27)<br>Choose from: **Zero**, **Constant** or **Random**. | | |
| **Zero** | The fast correction data exactly reflects the applied errors | | |


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| | |
|---|---|
| **Constant** | Determines an error for each UDREI value that corresponds with the value of **No. standard deviations**, as related to this UDREI. |
| **Random** | Determines errors randomly for each UDREI cell. The errors remain fixed throughout the run and any entry in **No. standard deviations** does not apply |
| **No. standard deviations** | A multiplying factor applied to the corresponding standard deviation for each GIVEI when determining the applied error for correction data |
| **GIVEI error mode** | Performs the same function as **UDREI error mode**, it adds errors to the Ionospheric correction data |

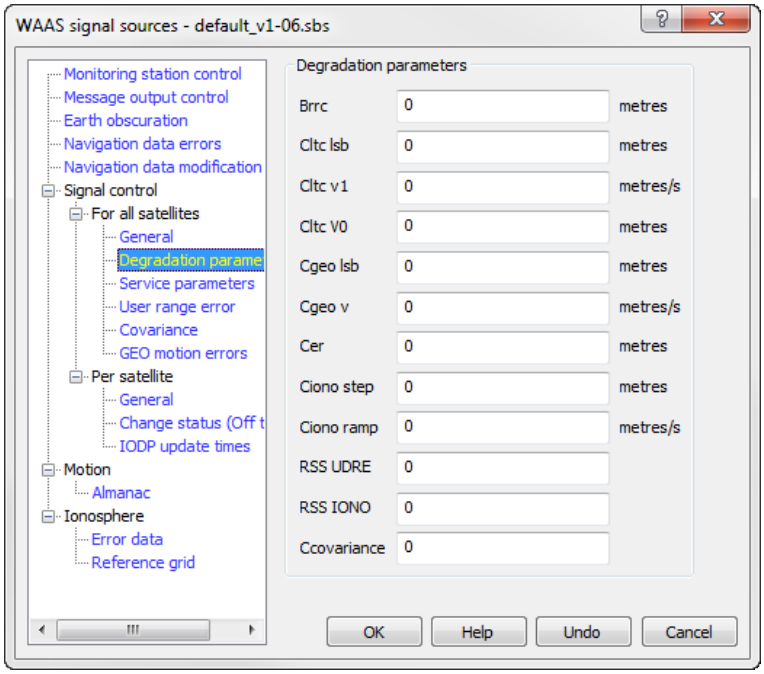
## 14.6.2 Degradation parameters

***Note:*** *The output intervals you specify for the relevant message types see* ***Message output control*** *(page 14-5) determine the message update intervals (Iltc_v1, Iltc_v0, Igeo, and Iiono).*

These parameters define the values the Degradation Parameters message (type 10) uses. SimGEN fixes these parameters throughout the run and they are the same for all SBAS satellites.

Reference d) describes the degradation parameters.

SimGEN inserts the values you enter in this dialog directly into the message.



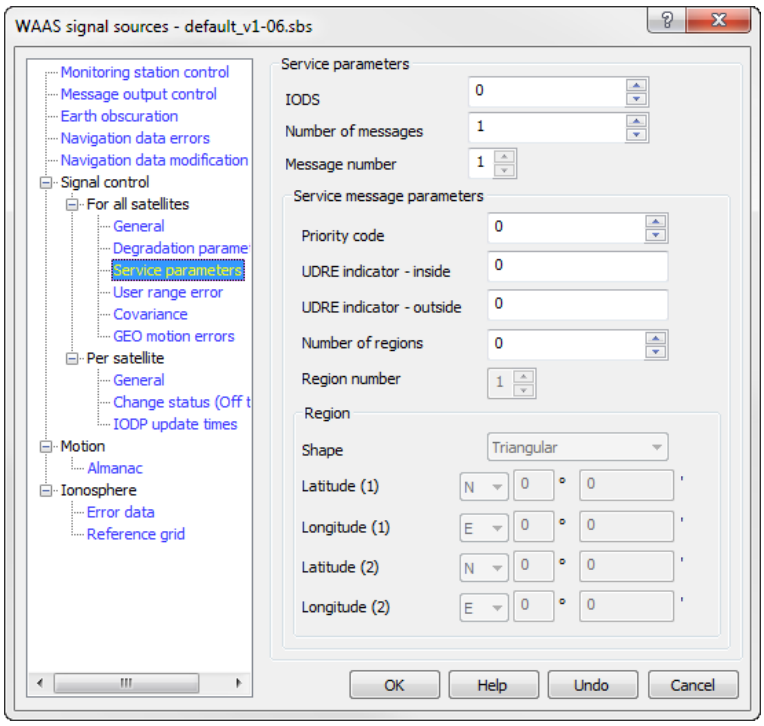

## 14.6.3 Service parameters

These parameters define values the SBAS Service message (type 27) uses. You can define up to eight service messages. For each service message, you can define up to five separate service regions in each message.

Reference d) describes the service parameters.

SimGEN inserts the values you enter in this dialog directly into the message.


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## 14.6.4 User range error

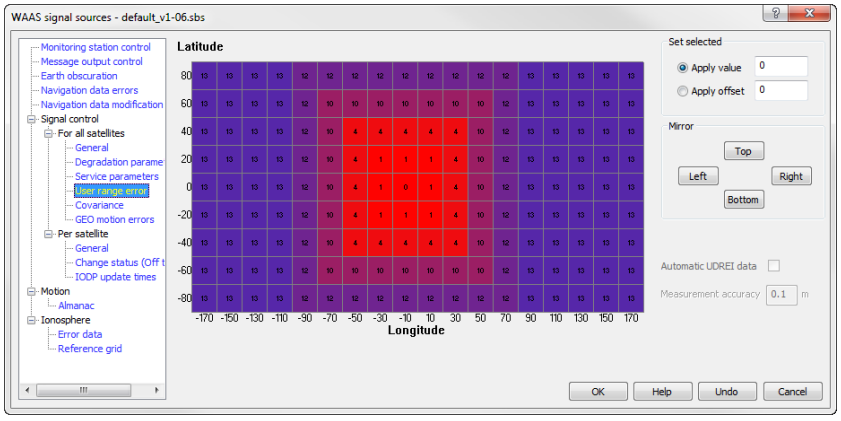
***Note**: Applicable error limits and the methods used in SimGEN may not exactly represent those used by the SBAS system, but they do fulfil the purpose of automatically providing realistic UDREI data as a function of the relative geometry of the ground stations and the satellites being tracked.*

The User Differential Range Error Indicator (UDREI) contained in the SBAS Fast Correction message indicates the accuracy of the correction data for individual satellites; see Table A-6 of reference d). The applicable value depends on the relative geometry of the monitored satellite and the SBAS ground stations for which this is visible.

There are two ways to define UDREI data:

→ You can use the SimGEN dialog in the figure below, which shows the latitude and longitude values at the centre of each cell; or

→ SimGEN can automatically generate the data.




If you use manual selection of UDREI data during the run, SimGEN uses a grid of values that you enter to determine the UDREI value for a monitored satellite. The grid effectively divides the surface of the Earth into cells, each of 20 degrees latitude by 20 degrees longitude.

To enter a UDREI value (which must be an integer between 0 and 15), open the dialog shown in the figure above:

→ Select **Set selected-Apply value**.

→ Type the **UDREI value** you want to use in the text box to the right of **Apply value**.

→ Click in the cells where you want to apply this UDREI value.


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→ You can also drag across multiple cells to enter this UDREI value in more than one adjacent cell.

To offset the UDREI value from those already present (the offset must be an integer between -15 and 15):

→ Select **Set selected-Apply offset**.

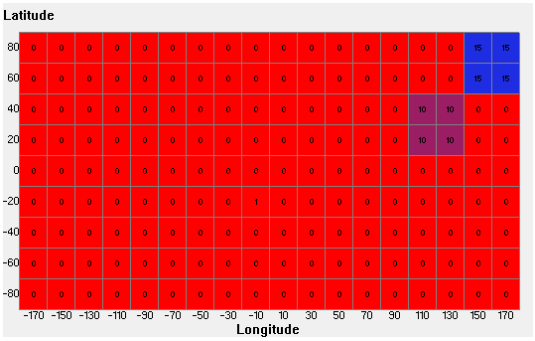
→ Type the UDREI offset you want to use in the text box to the right of **Apply offset**.

→ Click in the cell where you want to offset the current UDREI value by your chosen amount

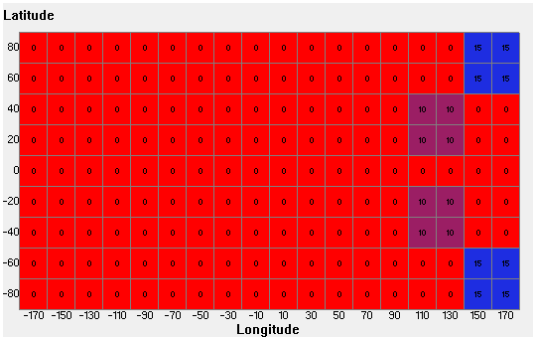
→ You can also drag across multiple cells to offset by this value in more than one adjacent cell

→ Values on cell boundaries correspond to the higher latitude / longitude. The figure below shows how you use the **Mirror** buttons to apply values or offsets about the cell with latitude = 0° or the cell boundary at -10° and 10° corresponding to longitude = 0°.

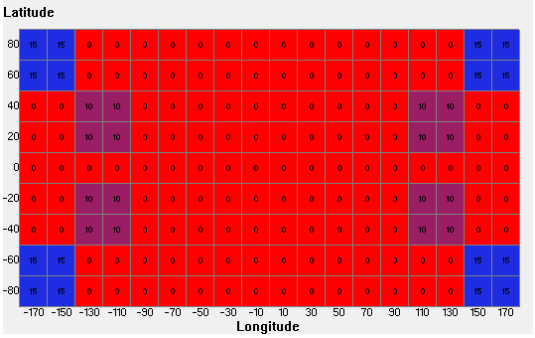
For example, enter the values you want to use in the top right-hand quadrant:




Click **Top** to mirror the values you entered to the bottom right-hand quadrant:




Click **Right** to mirror the values on the right-hand side to the left-hand side:




Lower UDREI values will apply in the general vicinity of the ground station locations. The grid value appropriate to the current position of a satellite, in terms of latitude and longitude, determines the UDREI value it uses.

**Automatic UDREI data** is only enabled if you select automatic ***Covariance*-Covariance data-automatic**.


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Selecting **Automatic UDREI data** uses the current covariance matrix data to determine an error limit for the satellite correction data.
***Note**: This does not require enabling of the Covariance Matrix message in the broadcast set.*

In determining applicable UDREI values, the covariance data uses **Measurement accuracy**, range: 0.01 to 10 metres, which represents a system wide limit for SBAS pseudorange measurement accuracy. Entering an optimistic value for **Measurement accuracy** lets you reduce the total number of ground station locations while giving “good” UDREI values.

Selecting **Automatic UDREI data** or amending the **Measurement accuracy** automatically updates the data in the UDREI grid, assuming a typical height value for a GPS satellite. Selecting **Automatic UDREI data** does not use the data values shown in the grid. These values do provide a useful means of checking the likely range of UDREI values that will occur during the run.

You can generate UDREI grid data by selecting **Automatic UDREI data**, see ***Covariance***. Deselecting **Automatic UDREI data** retains the generated data in the UDREI grid. You can then edit this data and save it by clicking **OK** and entering a suitable name for the **Signal sources file**. SimGEN will use this **Signal sources file** during the next simulation.

## 14.6.5 Covariance

***Notes**:*

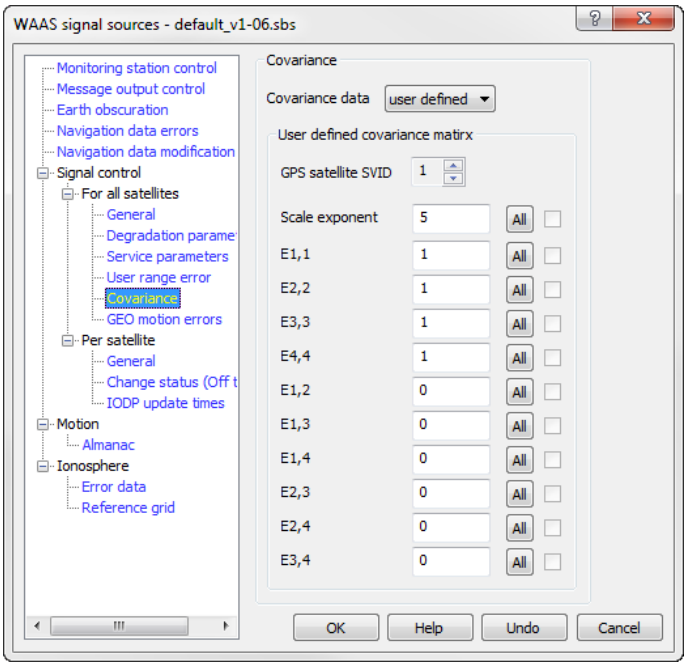
***1)** This data will not change during the run and is likely to become increasingly unrepresentative of the situation as the run progresses and the satellite positions change.*

***2)** SimGEN broadcasts covariance data for all currently visible GPS satellites, but not for SBAS satellites. In this context, a visible satellite is one seen by at least one monitoring station.*

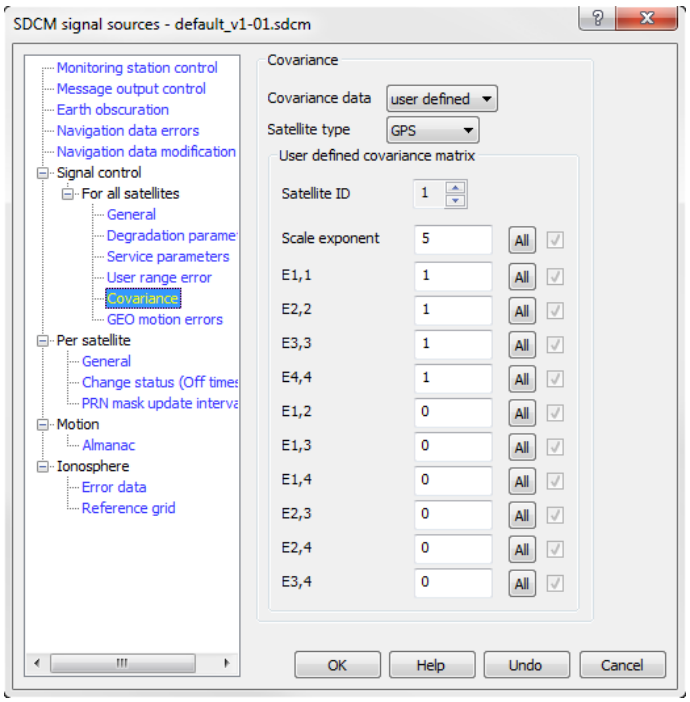
***3)** Currently, SimGEN version 5.04 onwards supports SDCM for the GSS6700 signal generator only*

The covariance matrix relates to the definition of the data in the **Clock-Ephemeris Covariance Matrix** message (MT28). You can define values for this data, or SimGEN can automatically generate it.

This figure shows the dialog for EGNOS, GAGAN, MSAS and WAAS:




This figure shows the dialog for SDCM:




The SDCM constellation allows you to select **Satellite type-GPS** or **-GLONASS**. SimGEN uses this selection in the message MT28 (Clock-ephemeris covariance matrix), see ***Message output control***, (page 14-5). If you use **SDCM-*Message output control*-Use fixed sequence**, you cannot send MT27 with MT28.

Reference d) describes the covariance matrix parameters for WAAS. Reference dd) describes the covariance matrix parameters for SDCM. SimGEN inserts the values you enter in the **Covariance** dialog directly into the message.

Select **Covariance data-user defined** and type values for each of the terms in the dialog. You can enter separate sets of data for each satellite by selecting **Satellite ID**. Ideally, the data values should reflect the relative geometry of the specified ground stations and the satellite at the start of the run.

If you arbitrarily define the covariance matrix data, or it becomes invalid with time, Spirent recommends you only use the data to verify receiver decoding of the message. Do not use the message for calculation of correction data degradation. Alternatively, you can set all the diagonal terms in the matrix to the same value and the off-diagonal terms to zero. This makes the degradation term independent of satellite and user position.

Selecting **Covariance data-automatic** ignores covariance data you define (the area for user-defined entries is disabled). SimGEN calculates the covariance data based on the relative ground station and satellite locations.

You must define at least four ground stations to use **Covariance data-automatic**.

Covariance data is determined and broadcast for all “visible” SBAS satellites. Selecting **Covariance data-automatic** defines a visible satellite as one for which a valid covariance matrix may be determined, so it must have line-of-sight visibility from at least four ground stations.

The covariance data updates every 10 minutes.

### 14.6.6 GEO motion errors

***Notes:***

***1)*** *This offset model is a simple method for generating meaningful SBAS correction data in the cases of the SBAS GEO satellites themselves.*
*It is not a realistic physical representation of real-world deviations in satellite motion or SBAS system operations.*

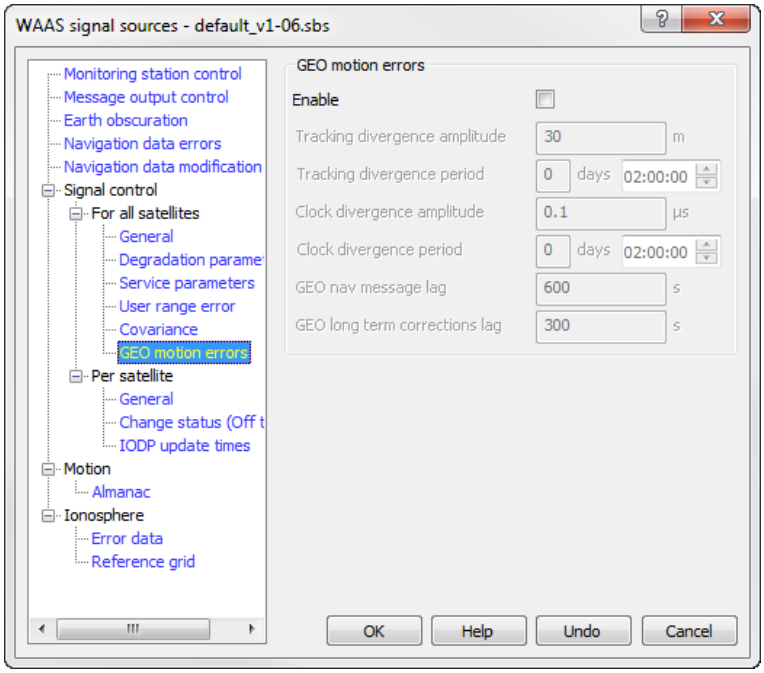
***2)*** *SBAS service providers do not broadcast long-term corrections data for their own GEO satellites, but only for “foreign” SBAS satellites. In the former case, the GEO nav data message should ideally include up-to-date compensation for deviation in satellite motion. In order to optimise consistency between successive data sets, there is some trade-off with the fast corrections data.*

***3)*** *When no long-term corrections apply for SBAS satellites, the fast corrections data will compensate for the offsets resulting from the defined lag in the GEO nav data message. As this correction is dependent on the ground station mapping, a small residual error may remain for the receiver location.*

***4)*** *The default parameter values shown below will result in a few metres of error in satellite position and simulated pseudorange.*


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**GEO motion errors** apply a simple sinusoidal offset model to SBAS satellite motion and the clock. It includes meaningful correction data for SBAS satellites in the broadcast fast corrections data and (when appropriate) the long-term corrections.




| | | | |
|---|---|---|---|
| **Enable** | Enable or disable these parameters without entering or deleting values.<br>Deselect (default): Disables these parameters<br>Select: Enables these parameters | | |
| ***Note**: Deselect (default) results in all corrections data broadcast for the SBAS satellite defaulting to zero.* | | | |
| **Tracking divergence amplitude** | The amplitude of the divergence in the satellite motion relative to its nominal path.<br>It applies a separate sinusoidal offset for each axis in the ECEF frame, with a randomly determined start phase for each axis and for different SBAS satellites.<br>The start phases are repeatable from run-to-run, but they will change if the scenario start-time varies (as a function of time-of-week). | | |
| **Tracking divergence period** | The period of the sinusoidal offset | | |
| | Units:<br>d hh:mm:ss | Range: 60 s<br>to 2 days | Default:<br>0 02:00:00 |
| **Clock divergence amplitude** | The amplitude of the sinusoidal satellite clock offset. It has a randomly determined start phase for each SBAS satellite. | | |
| | Units: microseconds | Range: 0 to 3 µs | Default: 0.1 |
| **Clock divergence period** | The period of the clock offset sinusoid | | |
| | Units:<br>d hh:mm:ss | Range: 60 s<br>to 2 days | Default:<br>0 02:00:00 |
| **GEO nav message lag** | The delay between the application of the motion and the clock offsets in the simulated signal, and the inclusion of these offsets when defining the content of the GEO nav data message.<br>It results in divergence of the expected satellite position and/or clock data relative to the simulation.<br>Use fast and long-term corrections as appropriate to compensate for the resulting error. | | |
| | Units: seconds | Range: 0 to 3 600 s | Default: 600 |


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| | | | |
|---|---|---|---|
| **GEO long term corrections lag** | The delay between the application of the GEO motion and clock offsets in the simulated signal, and the inclusion of these offsets when defining the content of the long-term corrections for SBAS satellites - when applicable, see Note 2 in the section below.<br>These long-term corrections are the difference between the parameter values predicted at the current time by the latest GEO nav message, and the current values, as calculated with the long-term correction lag you entered. | | |
| | Units: seconds | Range: 0 to 3 600 s | Default: 600 |

# 14.7 Signal control - Per satellite

You can control the signal of each satellite. In each dialog:

Select the **Satellite** using the up / down arrows. Click **Copy** to copy the data you enter to all satellites.

Click **All** to set the entry to all satellites.

## 14.7.1 General

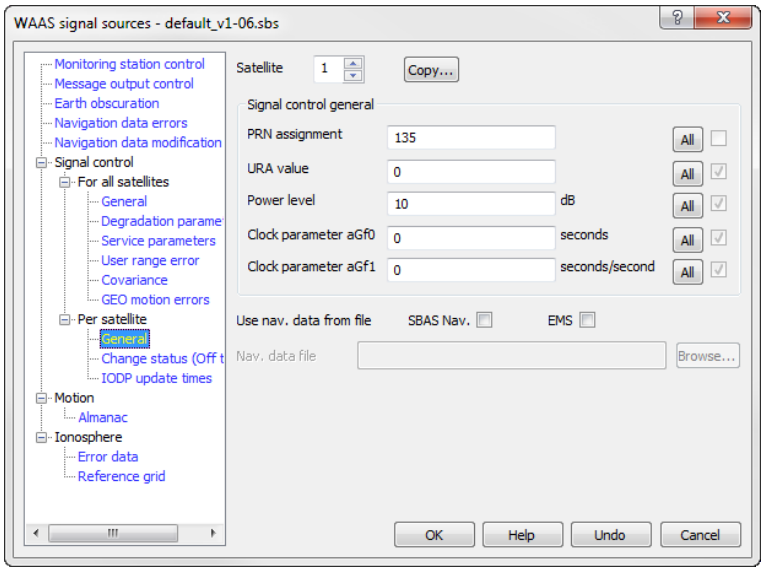
***Notes**:*

***1)** Spirent recommends you do not use the same PRN for different satellites, especially if the scenario you are running simultaneously simulates these satellites.*

***2)** Spirent recommends you do not specify the same PRN values for satellites in two different SBAS networks, as it could cause a problem for the receiver.*

***3)** Currently, SimGEN version 5.04 onwards supports SDCM for the GSS6700 signal generator only*

This dialog controls the signal-level characteristics of all simulated carrier frequencies at the RF output of the signal generator.




If you select **Signal control-*General*-Signal strength-Modelled** (page 14-9), SimGEN applies the values you enter in this dialog before performing modelling.

| | |
|---|---|
| **Satellite** | Select the **Satellite** whose settings you want to change. |
| **Signal control general** | Set the signal control parameters for the **Satellite** |


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| | | | |
|---|---|---|---|
| **PRN Assignment** | The SBAS ranging code (C/A).<br>You can assign any SBAS satellite in each SBAS constellation to any of the SBAS PRNs (see http://gpsworld.com/the-almanac/ for updates on PRNs):<br>EGNOS PRNs: 120, 124, 126, 130, 131<br>GAGAN PRNs: 127, 128, 129, 133, 136<br>MSAS PRNs: 129, 132, 133, 136, 137<br>SDCM PRNs: 125, 140, 141<br>WAAS PRNs: 121, 122, 134, 135, 138 | | |
| | Units: none | Range: 120 to 158 | Default: constellation dependant |
| **URA value** | Broadcast in the GEO Navigation message (type 9) | | |
| | Units: none | Range: 0 to 15 | Default: 0 |
| **Power level** | Click All to set the entry to all satellites. | | |
| | Units: dB | Range: ± 20 dB | Default: 10 |
| **Clock parameter aGf0** | SBAS clock offset term broadcast in the GEO Navigation message (type 9). Also applies to the SBAS signal. | | |
| | Units: seconds | Range: ± 9.537 E-07 s | Default: 0 |
| **Clock parameter aGf1** | SBAS clock drift term broadcast in the GEO Navigation message (type 9). Also applies to the SBAS signal. | | |
| | Units: seconds per second | Range:<br>± 1.164 2 E-10 $s.s^{-1}$ | Default: 0 |
| **Use nav. data from file** | ***SBAS Navigation Data file*** (page 14-19) gives the file format | | |
| **SBAS Nav** | Deselect (default): does not get Nav data from a symbol file.<br>Select: Replaces SimGEN's internally generated SBAS Nav data with Nav data read from a user-defined ASCII file, which must:<br>1) Contain the full (contiguous) message stream for the satellite<br>2) Use 500 symbols to represent each one-second duration of the SBAS message<br>3) Use the SBAS Nav Data File Format, see below<br><br>Click **Browse** and navigate to the SBAS Nav data file you want to use, the default extension for symbol files is **.sbas_nav*, see ***SBAS Nav Data Extract utility*** (page 26-51). | | |
| **EMS** | Deselect (default): does not get data from an EMS (EGNOS Message Server) file<br>Select: Replaces SimGEN's internally generated SBAS Nav data with Nav data read from an EMS file.<br>You can get details on the format of EMS files and download real-world EGNOS data from the EGNOS website www.egnos-pro.esa.int/ems/index.html.<br>Click **Browse** and navigate to the EMS data file you want to use, the default extension for EMS files is **.ems"*. | | |
| ***Note**: Ensure the scenario time matches the time of the data file you downloaded.<br>A "Data time does not match scenario time" message will result if the scenario time does not match the time of the downloaded file.* | | | |

#### 14.7.1.1 SBAS Navigation Data file format

You can replace SimGEN's internally generated SBAS Navigation data with Navigation data read from a user-defined ASCII file. This file must:

- → Contain the full (contiguous) message stream for the satellite
- → Use 500 symbols to represent each one-second duration of the SBAS message
- → Use the following format:


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Lines starting with an “!” are comments and are ignored.

The first line of data contains the scenario start time and date in DEC time format (DD-MMM-YYYY HH:MM:SS). The scenario arming stage checks this time.

Lines two onward contain the Navigation data. Each line contains 500 bits of Navigation data (one second of data), stored as 125, 4-bit hexadecimal characters. The first bit of the sequence being the MSB of the first hexadecimal characters.

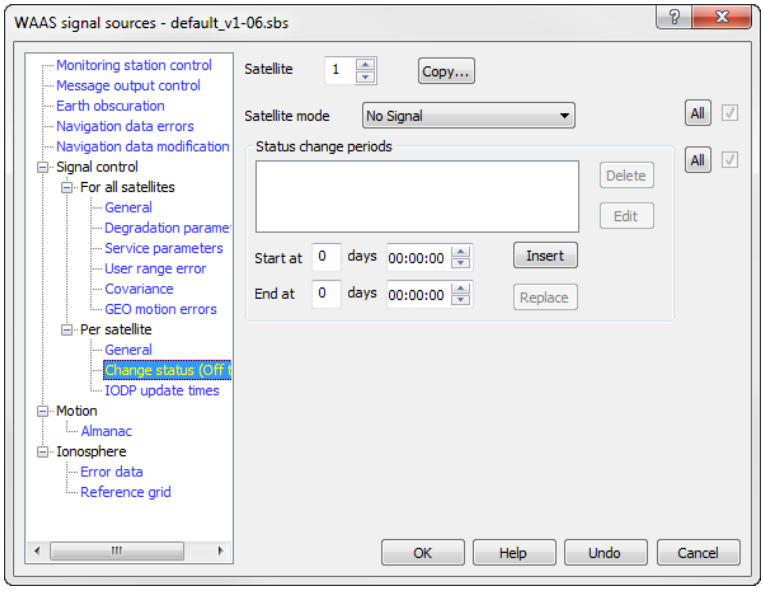
For example:

```
!This is a comment
01-JAN-2002 00:00:00
38763D5C74AB00000000000000000000000000000000000000000000000000000000000000000000000000000000000000
000000D94FFFFFFFFFFFFFFFFFFF1DA0B39D8A5F
F0419E9EF8F26B0D94FFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFF
FFFFFFFFFFFFFFFFFFFFFFFFFFFF1EFDCF862264
522E36FBC70000000000000000000000000000000000000000000000000000000000000D4DB000000000000000
00000000000000000000000000000DACBCF4603711
```

## 14.7.2 Change status (Off times)

***Note**: When you use the SBAS constellation editor to set a satellite OFF at a specific time, SimGEN sets that satellite OFF in the one second (typically 0.6 seconds) before the time you specify. This ensures any replacement hardware channel starts at the correct time.*
*SimGEN does not set the satellite OFF early when you set the satellite OFF using a User Actions file.*

This figure shows the **Off times** dialog.




| | |
|---|---|
| **Satellite** | Select the **Satellite** whose settings you want to change.<br>Click **Copy** to copy these parameters to the Satellites you select in the dialog. |
| **Satellite mode** | Characteristics of satellite ‘off’ periods.<br>Click All to apply the **Satellite mode** to all Satellites. A tick next to the All button confirms this action.<br>Choose from: |
| **O/p test message** | Broadcasts the SBAS test message (Type 0). |
| **No signal** | (default) Turn off the satellite |
| **Ranging off** | Selected in the GEO Almanacs message (Type 17) |
| **Corrections off** | Selected in the GEO Almanacs message |
| **Integrity off** | Selected in the GEO Almanacs message |


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| | | | |
|---|---|---|---|
| **All Health Bad** | All health bits are set (off) | | |
| **Type 0 replaces Type 2** | Test mode | | |
| **Start at**<br>**End at** | Units:<br>days hh:mm:ss | Range: 0 00:00:00<br>to 23 23:59:59 | Default:<br>0 days 00:00:00 |

Type the **Start at** time and **End at** time click **Insert**. The times appear in the **Status change periods** area. There is no limit to the number of **Start at** / **End at** times.

Select a time in the **Status change periods** area and click **Edit** to edit the **Start at** / **End at** times.

Select a time in the **Status change periods** area and click **Replace** to replace these times with the times currently in the **End at** and **Start at** text boxes.

Select a time in the **Status change periods** area and click **Delete** to delete these **Start at** / **End at** times.

Click **All** to apply the times in the **Status change periods** area to all **Satellites**. A tick next to the **All** button confirms this action.

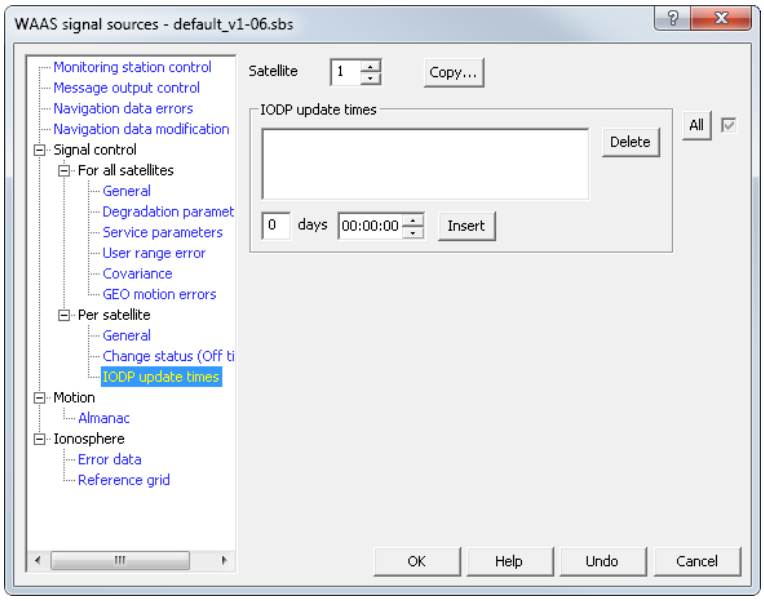
### 14.7.3 IODP Update times

***Notes***

***1)*** *The SDCM constellation does not use this parameter****2)*** *Setting the* ***IODP Update times*** *will not change the contents of the PRN mask itself*

***3)*** *Currently, SimGEN version 5.04 onwards supports SDCM for the GSS6700 signal generator only*

Set the IODP update time using this dialog. Setting to non-zero will cause the IODP value to increment at the given time into the run.




| | | |
|---|---|---|
| **Satellite** | Select the **Satellite** whose settings you want to change.<br>Click **Copy** to copy these parameters to the Satellites you select in the dialog. | |
| **IODP update times** | Units: days hh:mm:ss | Default: 0 days 00:00:00 |

Click **Insert** to transfer the time to the **IODP update time** area.

Select an entry in the **IODP update times** area and then click **Delete** to delete that entry.


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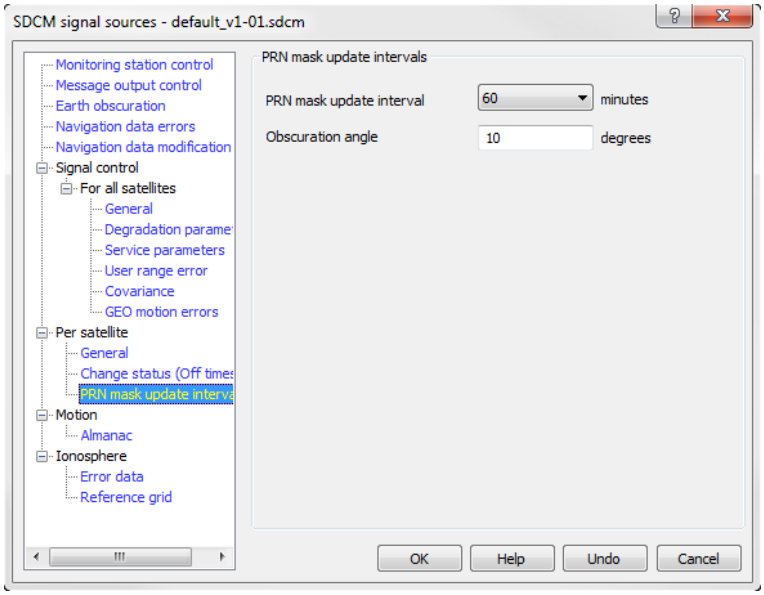
### 14.7.4 PRN mask update intervals (SDCM only)

***Notes**:*

***1)** Currently, SimGEN version 5.04 onwards supports SDCM for the GSS6700 signal generator only*

***2)** If you only enable GPS or GLONASS, you do not need to use the dynamic PRN mask; in this case, the number of satellites will not exceed the ICD limit of 51 in the PRN mask*

SimGEN uses this to implement a dynamic PRN mask to restrict the number of SDCM satellites to be within a maximum of 51 for which correction data is broadcast:

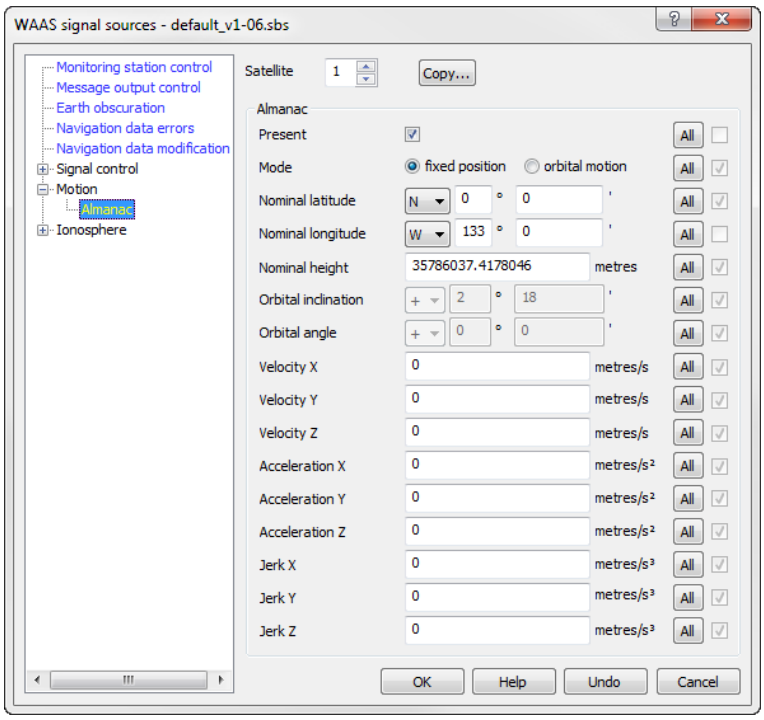



| | | | |
|---|---|---|---|
| **PRN mask update intervals** | At each **PRN mask update interval**, SimGEN uses the dynamic PRN mask method to determine a list of satellites for which correction data is broadcast. SimGEN includes satellites in the PRN mask after evaluation using two criteria:<br>→ Visibility to the service region relating to the SDCM satellite. SimGEN only includes visible satellites, determined using **Obscuration angle**<br>→ Visibility to SDCM ground monitoring stations | | |
| **PRN mask update interval** | Choose the interval, in minutes, from:<br>**60** (default):<br>**30**: | | |
| **Obscuration angle** | Satellite visibility determines which satellites are visible from the service region relating to the SDCM satellite. The Earth masks satellites below the **Obscuration angle** and SimGEN will not simulate satellites below this angle. | | |
| | Units: degrees | Range: 0 to 10° | Default: 10 |

## 14.8 Motion-Almanac

There is one dialog for each geostationary satellite in the SBAS constellation.


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For all parameters, click **All** to use the current value for all **Satellites**.

| | | | |
|---|---|---|---|
| **Satellite** | Select the **Satellite** whose settings you want to change.<br>Click **Copy** to copy these parameters to the Satellites you select in the dialog. | | |
| **Present** | Select to include **Satellite** in scenario.<br>Deselect to treat **Satellite** as non-existent. | | |
| **Mode** | Choose from a satellite in a **fixed position** (default) enables **Nominal latitude**, **Nominal longitude**, **Nominal height**, **Velocity X** to **Z**, **Acceleration X** to **Z** and **Jerk X** to **Z**)<br>or one with **orbital motion** (enables **Nominal longitude**, **Nominal height**, **Orbital inclination** and **Orbital angle**) | | |
| **Nominal latitude** | Units: degrees, minutes | Range: N 90° 0.0′ to S 90° 0.0′ | |
| **Nominal longitude** | Units: degrees, minutes | Range: W 180° 0.0′ to E 180° 0.0′ | |
| **Nominal height** | Units: metres | Range:<br>35 E+6 to 36.5 E+6 m | Default:<br>35 786 037.417 804 6 |
| **Orbital inclination** | Units: degrees, minutes | Range: ± 180° 0.0′ | |
| **Orbital angle** | Units: degrees, minutes | Range: ± 180° 0.0′ | |
| **Velocity X,**<br>**Velocity Y,**<br>**Velocity Z** | Units: metres per second | X and Y Range:<br>± 20.48 $m.s^{-1}$<br>Z Range:<br>± 327.68 $m.s^{-1}$ | Default: 0<br>See Note below |
| **Acceleration X,**<br>**Acceleration Y,**<br>**Acceleration Z** | Units: metres per $(second)^2$ | X and Y Range:<br>± 0.0032 $m.s^{-2}$<br>Z Range:<br>± 0.0256 $m.s^{-2}$ | Default: 0<br>See Note below |
| **Jerk X,**<br>**Jerk Y,**<br>**Jerk Z** | Units: metres per $(second)^3$ | X, Y and Z Range:<br>± 5 E-9 $m.s^{-3}$ | Default: 0<br>See Note below |


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***Note**: If you use the **Velocity**, **Acceleration** and **Jerk** terms in the SBAS Nav data message, Spirent recommends you use small values, since their effects are cumulative with time and could rapidly become very large.*
*The default, and safest, values are zero.*

## 14.9 Ionosphere

***Note**: Certain grid points are common between Bands 0 to 8 and Bands 9 and 10.*

Various locations on the Earth measure Ionospheric delay data. SBAS satellites broadcast this as Ionospheric Delay Correction data using a reference grid covering the full surface of the Earth. The correction data consists of:

- Vertical Ionospheric delay
- Error estimates

To determine points on the reference grid, the grid is broken down into sub-sections or Bands.

Bands 0 to 8 include North and South hemisphere latitude values for a limited range of longitude (40 degrees) on a Mercator projection map, giving 1808 points in total.
Bands 9 and 10 define a total of 384 points in the North and South Polar Regions.

In practice, SBAS satellites only broadcast correction data for the Bands and grid points in the geographical area of the SBAS service provider.

Message type 18 (MT18) provides a Band mask that defines the grid points in use for each Band being broadcast.

Message type 26 (MT26) provides the Ionospheric Delay Corrections that relate to the points defined by each valid Band mask.

In SimGEN, the Ionospheric Delay Corrections broadcast in MT26 are the vertical delay values, calculated using the GPS (Klobuchar) Ionospheric model, at the valid grid points. The Ionospheric correction values are consistent with the delays applied in the simulated GPS signals and change with time. The errors for the Ionospheric correction values are determined by a separate, user-defined, grid that allows you to assign specific error indicator (GIVEI) values for different areas of the world (in blocks of 20° latitude by 20° longitude). This allows you to assign larger values of GIVEI to those locations where the uncertainty in the measurement is likely to be higher, for example, near the equator. However, this is not a physical realisation of measurement error and does not change with time.

You can also use the GIVEI values to introduce an element of error into the correction data, see **Signal control-For all satellites-*General*-Signal errors-GIVEI error mode** (page 14-9).

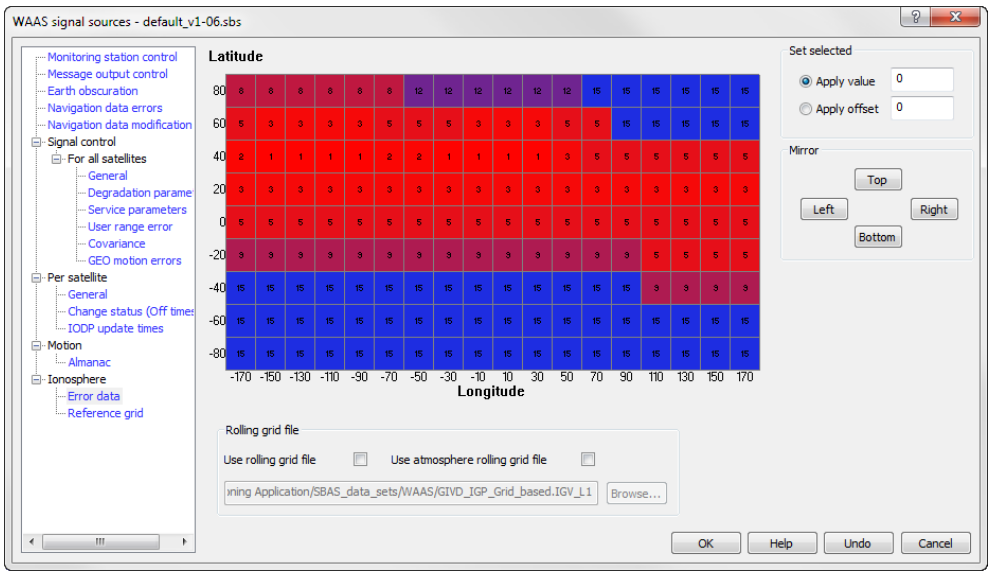
SimGEN lets you define the Bands broadcast by each SBAS satellite, together with the grid points to use within these Bands, using one of two methods:

- The full method and the method Spirent recommends. It lets you define the reference grid (by enabled / disabling blocks of longitude and latitude) and individually select the relevant Bands for each SBAS satellite.
- The abridged method, for legacy reasons this is the SimGEN default. This method allows you to specify the number of Bands (in Bands 0 to 8) to be broadcast, the latitude sets to use and a longitude interval for the grid points in the sets you select. The same Band selections apply to both North and South hemispheres.
  The Band numbers broadcast relate to the location of the SBAS satellite.
  You can individually define Bands 9 and 10.

### 14.9.1 Ionosphere - Error data

This dialog shows a grid of GIVEI error data values used in MT26 (the Ionospheric Delay Corrections message). It is similar to the dialog for defining UDREI values:


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**Signal control-For all satellites-*User range error*** (page 14-13) details entering data using **Apply value** and **Apply offset** and using the **Mirror** buttons.

The GIVEI value is determined for the GIVEI grid-point that is closest to the Ionospheric grid-point (in terms of latitude and longitude) you enable. The dialog shows values for **Latitude** and **Longitude**, which are the centre values of each block and cover ±10 degrees. Values on block boundaries correspond to the higher latitude / longitude.

| | |
|---|---|
| **Rolling grid file** | Selecting **Use rolling grid file** in the **<constellation>-signal sources file** results in broadcast of the ionospheric delays in the navigation message.<br>Selecting **Use atmosphere rolling grid** uses the rolling grid file you define in **Atmosphere-*Terrestrial iono model - GPS and default model*-Use rolling grid file** (page 9-3) to calculate both the delays broadcast in the navigation data message and the ionospheric delays present in the simulated RF signal. |


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| | |
|---|---|
| **Use rolling grid file** | Deselect (default): Do not use a rolling grid file<br>Select: Uses a grid-based ionospheric model according to the rolling grid file you select.<br>By default this area shows the location of the default grid data file …/*SBAS_data_sets/<constellation>/GIVD_IGP_Grid_based.IGV_<frequency>* that Spirent provides; where *<frequency>* indicates the frequency as follows:<br>1) **.IGV_L1* (and **.IGV*) is a data file with delay values with respect to L1. When the rolling grid file provides ionospheric delays with respect to L1 for a satellite broadcasting on L2 or L5, SimGEN scales the ionospheric delays to L2 or L5 and then applies the delay values to the navigation data message.<br>2) **.IGV_L2* is a data file with delay values with respect to L2.<br>**.IGV_L5 is* a data file with delay values with respect to L5.<br>When the rolling grid file provides ionospheric delays with respect to a frequency other than L, SimGEN first scales the delays to L1; then scales from L1 to the frequency the satellite is using; and finally applies the delay values to the navigation data message.<br><br>These files have the default locations:<br>C50r SimGEN Host:<br>*D:\posapp\software\<version>\gui\SBAS_data_sets\<constellation>*<br>SimGEN Controller:<br>*C:\Program Files\Spirent Communications\Positioning Application \SBAS_data_sets\<constellation>*<br><br><*constellation*> refers to one of EGNOS, GAGAN, MSAS, SDCM or WAAS<br><br>***Rolling grid iono file format*** (page 9-9) describes the file format<br><br>Click **Browse…** to navigate to an “external” rolling grid file you want to use. The location of this file can be any folder on your C50r SimGEN Host or SimGEN Controller.<br>The text “Linked” shows SimGEN links the file shown to the scenario.<br>Click **Import** to navigate to a rolling grid file, as when clicking **Browse…** However, when you click **Open** in the dialog and select a file, SimGEN will import this file into the same folder as the file referencing it. This may be a scenario file (**.scn*) or the ‘shared’ folder; but, it is more likely to be a scenario source file, such as the signal sources file (**.sbe, *.sbg, *.sbm, *.sdcm, *.sbs*) here. SimGEN automatically updates the path to the file.<br>The text “Importing” shows SimGEN will import the rolling grid file you select, rather than referencing the file from its original location.<br>Notice SimGEN completes the import of the file when you click **OK** and save the new signal sources file to a name of your choice.<br>Subsequently, when you open this signal sources file, the rolling grid file you selected appears in the text area without a pathname, since it is present in the scenario folder.<br>The text “Linked” shows SimGEN links the file shown to the scenario. |

***Notes**:*

***1)** Selecting **Use rolling grid file** applies the ionospheric delay only to the navigation data message*

***2)** For GPS and SBAS constellations, the navigation data message always broadcasts ionospheric delays with respect to L1*

***3)** You can only **Import** a rolling grid file*

| | |
|---|---|
| **Use atmosphere rolling grid file** | Deselect (default): Uses the rolling grid file you select in **Use rolling grid file**<br>Select: Uses the atmosphere rolling grid file you select in **Atmosphere-*Terrestrial iono model - GPS and default model*-Use rolling grid file** (page 9-3) |

***Notes**:*

***1)** Selecting **Use atmosphere rolling grid file** applies the ionospheric delay only to the simulated RF output*

***2)** Selecting **Use atmosphere rolling grid file** in this dialog without selecting a grid data file; or not selecting **Atmosphere-*Terrestrial iono model - GPS and default model*-Use rolling grid file** (page 9-3), results in an error message in the **System Messages** window (page 3-15).*

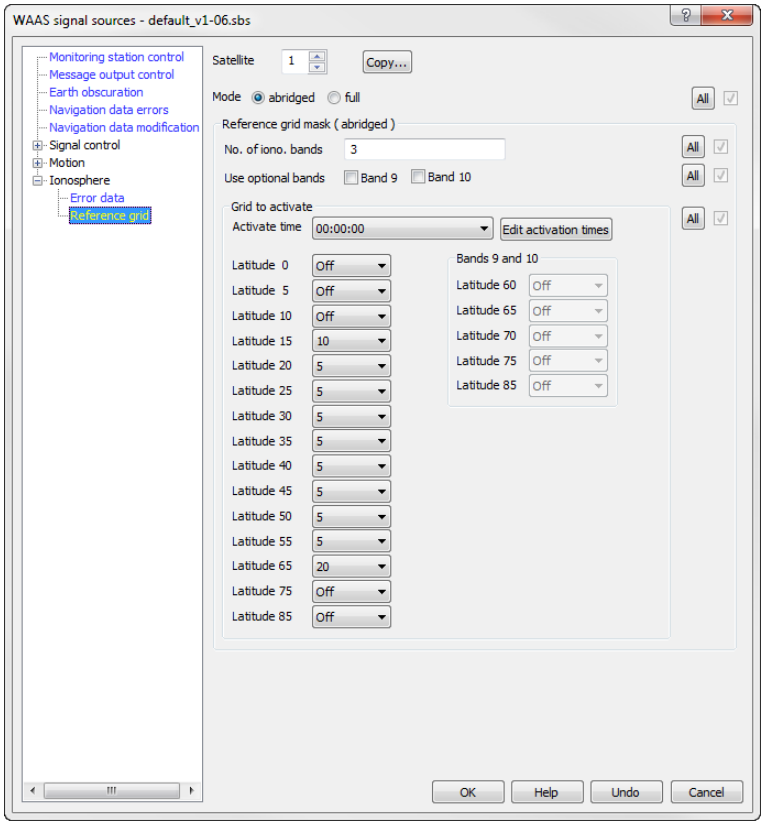

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## 14.9.2 Ionosphere - Reference grid- abridged

***Note**: Spirent recommends you use **Ionosphere - Reference grid-full** (page 14-29), which gives full grid definition.*

This default setting is the SimGEN legacy method for defining the content of MT18.

Use **Reference grid-abridged** to select the number of bands for broadcast and apply sub-sets of grid points at various latitudes.




**Reference grid-abridged** applies the same definitions to all bands for both North and South hemispheres. Direct control of individual grid points is not possible.

You can use **Reference grid-abridged** to define different sets of reference grid masks. Each grid mask can take effect at different times in the run. Set these times using **Edit activation times** in ***Reference grid-***. When SimGEN switches to a new grid mask, it increments the associated IODI transmitted in MT18 and MT26.

| | |
|---|---|
| **Satellite** | Select the **Satellite** whose settings you want to change.<br>Click **Copy** to copy these parameters to the Satellites you select in the dialog. |
| **Mode** | Choose from **abridged** (default) or **full** |


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| | |
|---|---|
| **No. of iono. Bands** | The number of different band masks for broadcast in MT18 and MT26.<br><br>Bands 0 to 8 are consecutive bands, centred at the location of the transmitting satellite.<br>SimGEN will optimally select and use a subset of these bands as defined by your entry for **No. of Iono bands**.<br>SimGEN always selects bands to achieve even coverage of ionospheric grid points by placing the broadcasting SBAS satellite at the centre, as in these examples.<br><br>**Odd number of bands, greater than one**<br>SimGEN places the satellite in the central band with the remaining bands equally placed either side of the central band.<br><br>**Even number of bands with the SBAS satellite positioned precisely in the centre of a band**<br>Two bands<br>SimGEN selects the band with the satellite in its centre and the next band towards the East, for example:<br>Positioning satellite with PRN 138 at 0° latitude, 0° longitude:<br>Using **No. of iono. bands-2**<br>SimGEN selects iono bands:<br>4: covering 20° W to 20° E (satellite in the centre of this band)<br>5: covering 20° E to 60° E (SimGEN selects the band to the East)<br><br>More than two bands<br>SimGEN selects one band for the satellite and additional bands either side of the satellite to achieve even coverage, with the final band always to the East, for example:<br>Positioning satellite with PRN 138 at 0° latitude, 0° longitude:<br>Using **No. of iono. bands-4**<br>SimGEN selects iono bands:<br>3: covering 60° W to 20° W (SimGEN selects one band to the West),<br>4: covering 20° W to 20° E (satellite in centre of this band),<br>5: covering 20° E to 60° E (SimGEN selects one band to the East),<br>6: covering 60° E to 100° E (SimGEN selects the “final” band to the East)<br><br>**Even number of bands with the SBAS satellite not positioned in the centre of a band**<br>Two bands<br>SimGEN selects the band covering the geographical position of the satellite and the nearest band to the satellite. For example, moving the above satellite to 1° W:<br>Using **No. of iono. bands-2**<br>SimGEN selects iono bands:<br>3: covering 20° W to 60° W (SimGEN selects the band nearest the satellite)<br>4: covering 20° W to 20° E (satellite is at 1° W)<br><br>More than two bands<br>SimGEN selects one band for the satellite and additional bands either side of the satellite to achieve even coverage, with the “final” band always nearest the satellite. For example using the satellite above (at 1 ° W):<br>Using **No. of iono. bands-4**<br>SimGEN selects iono bands:<br>3: covering 100° W to 60° W (the “final” band nearest the satellite)<br>4: covering 60° W to 20° W (SimGEN selects one band to the West)<br>5: covering 20° W to 20° E (satellite is at 1° W)<br>6: covering 20° E to 60° E (SimGEN selects one band to the East)<br><br>With Bands 0 to 8, you can select a longitude interval to determine the points SimGEN uses at the latitudes shown. |


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| | |
|---|---|
| ***Note***: *The same selection applies to all Bands, so that for latitude 15 degrees, you can select a spacing of 5, 10, 15 or 20 degrees. If you select 15 degrees, then points at longitude of 0 degrees, ±15 degrees, ±30 degrees and so on would be valid. Select* **Off** *to disable all points.* | |
| **Use optional bands** | Select **Band 9** and/or **Band 10** to include Ionospheric grid points in MT26 for the optional Bands 9 and 10.<br>Select these grid points in the same way as for Bands 0 to 8.<br>You must use the same Latitude for both Band 9 and Band 10. |
| ***Note***: ***Band 9*** *(Arctic areas) and* ***Band 10*** *(Antarctic areas) include grid points that are duplicated in Bands 0 to 8. SimGEN accepts duplicate points.* | |

In order from top-to-bottom, the four **All** buttons let you (using the figure above as an example):

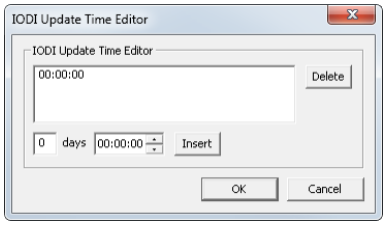
- → Set the **Mode** of all satellites to **abridged**
- → Set all SBAS **Number of Iono bands** to 3
- → Set all SBAS **Iono bands 9 and 10** to the current setting
- → Set the SBAS **Iono grid** to the current setting

In the confirmation dialog, click **Yes** to confirm the action or **No** to make no change. If you click **Yes**, a tick appears in the rectangular box next to the button to indicate your choice.

#### 14.9.2.1 Reference grid-Edit activation times

Use the **IODI Update Time Editor** to select update times for the Ionospheric grid mask and the corresponding IODI. For each time you specify (time in run) you can define a new set of enabled grid points.

Click **Edit activation times** to display the **IODI Update Time Editor**:




Click **Insert** to transfer the time you enter (d hh:mm:ss) to the **IODI Update Time Editor** area.

Select an entry in the **IODI Update Time Editor** area and click **Delete** to delete that entry.

**OK** - transfers the times in the **IODI Update Time Editor** area to the **Activate time** drop-down.

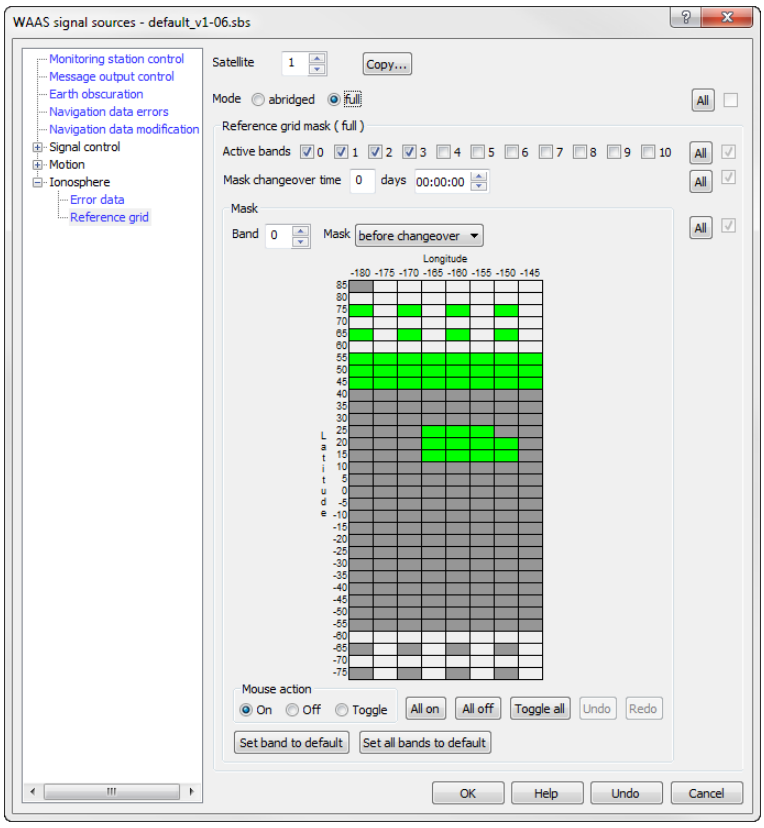
### 14.9.3 Ionosphere - Reference grid-full

***Note****: If you enable Band 9, there is overlap of valid grid points for this Band with those in Bands 0 to 8. This overlap will not cause a conflict in SimGEN. However, you may want to allocate the validity of common points to reduce message lengths or more accurately represent actual broadcast SBAS messages.*

**Reference grid-full** gives full control over the Ionospheric grid mask and the active Bands allowing a more realistic representation of the real-world allocation of grid points. By default, **Reference grid-full** enables the Bands and initialises them to give a realistic representation of the expected real-world monitoring locations for the WAAS and SBAS service areas. MSAS defines these in a more arbitrary manner.
You can enable and disable Bands and grid points as required.

This figure shows the dialog for Bands 0 to 8.

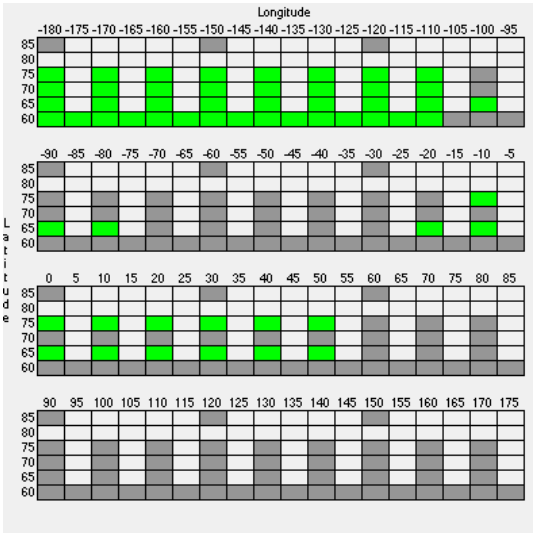

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The selection in **Active bands** varies with SBAS constellation:

| Constellation | Active bands selected |
|---|---|
| WAAS | 0, 1, 2, 3 |
| EGNOS | 3, 4, 5 |
| MSAS | 6, 7, 8 |
| GAGAN | 6, 7, 8 |

The figure below shows the Mask for Band 9, which covers ±180 degrees longitude for latitude 60 to 85 degrees.




Band 10 covers ±180 degrees longitude for latitude -35 to -60 degrees.


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Use the **Reference grid mask (full)** area to select the **Active bands** you want to use and to set the **Mask changeover time**. There is no mask changeover if you leave the **Mask changeover time** at zero, the scenario then uses the mask points set in **Mask-before changeover**.

Use the **Mask** area to set the mask for each **Band**. You can define two sets of mask data for each Band. The first set (**Mask-before changeover**) defines the mask at the start of the run. This mask remains in place until the **Mask changeover time** you specify. The second set (**Mask-after changeover**) defines the mask to use after the **Mask changeover time** you specify.

**Reference grid-full** limits you to applying two masks, **before changeover** or **after changeover**.

For each Band, a colour-coded block grid shows each potential grid location as latitude and longitude. This table details the colour codes.

| Block colour code | Description |
|---|---|
| **Green** | Data for this Band and Grid mask location is enabled |
| **Dark grey** | Data for this Band and Grid mask location is disabled |
| **Light grey** | Broadcast messages do not contain data corresponding to this location |

This table shows the ways you can set the mask points using the buttons in the **Mask** area.

| Control | Function |
|---|---|
| **Buttons** | |
| **All on** | Enables all mask points |
| **All off** | Disables all mask points |
| **Toggle all** | Toggles all mask points enabled - disabled |
| **Undo** | Undo last action |
| **Redo** | Redo last action |
| **Set band to default** | Sets all grid points in the Band to typical or expected values |
| **Set all bands to default** | Sets all grid points in all Bands to typical or expected values |
| **Mouse action** | |
| **On** | Enable mask points by dragging the mouse |
| **Off** | Disable mask points by dragging the mouse |
| **Toggle** | Toggle state of mask points by dragging the mouse |

In order from top-to-bottom, the four **All** buttons let you:

- → Set the **Mode** of all satellites to **full**.
- → Set the **Active bands** of all satellites to the current settings.
- → Set the **Mask changeover time** to the time you enter for this satellite.
- → Set the Mask points of all satellites to the current settings.

In the confirmation dialog, click **Yes** to confirm the action or **No** to make no change. If you click **Yes**, a tick appears in the rectangular box next to the button to indicate your choice.


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# 15 GBAS constellation editor

***Notes**:*

***1)** Spirent recommends you refer to the appropriate references, see the table below.*

***2)** Currently, Spirent does not support Message type 1, 2, or 3 from file.*

***3)** Currently Spirent only supports Message type 4, see reference h), from file.*

SimGEN supports simulation of Ground-based Augmentation Systems (GBAS), in particular the North American system known as LAAS. LAAS enables use of satellites in the GPS constellation (only) for the precision guidance of aircraft approach and landing. This Chapter describes how you define a scenario containing a LAAS transmission source.

This table details the available references for the different versions of DO-246:

| DO-246 | Reference |
|---|---|
| Version A | f) |
| Version B | f) |
| Version C | g) |
| Version D | h) |

Notice that Spirent does not claim full compliance to any of the LAAS system specifications in the table above. Spirent comply only with the relevant parts of the LAAS system specifications that cover GNSS applications. Contact Spirent Global Services if you need further assistance.

Your selection of the version in **General-Message format**, enables or disables various parameters. This document identifies those parameters.

Using the message types defined for the system, SimGEN compiles the errors into differential correction data (Message Type 1). This data is for transmission to the airborne receiver under test. Apart from the differential corrections, SimGEN can provide fixed data related to the airport and the landing system (Message Types 2 and 4).

The resulting LAAS data is available at the RS232 port and / or the Spirent GSS4150 VHF Data Broadcast Generator reference mm).

To use the GBAS constellation, first see **Receive and transmit antennas-*Associate a GNSS signal with an antenna*** (page 23-4) and associate the LAAS signal with the antenna(s) you want to use.

## 15.1 LAAS constellation editor

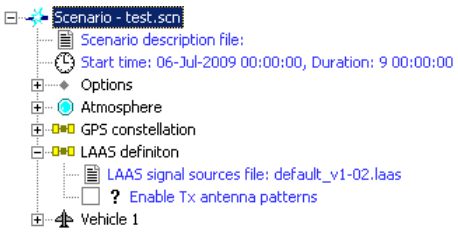
***Note**: The range of parameter values you can enter in PosApp may be different from the values commonly used in satellite navigation systems.*

Use the constellation editor to edit data in the LAAS constellation file. The editor shows the data in the LAAS constellation file as a series of “pages”. The left-hand area shows the pages you can select for editing, the right-hand area shows the details of the page you selected in the left-hand area. This section describes how you select and change details in the right-hand area.

SimGEN checks the range of the value you type in a text box and, if incorrect, displays the range of acceptable values.

After associating the LAAS signal type with an antenna, the LAAS constellation file appears in the **Scenario contents** window:.


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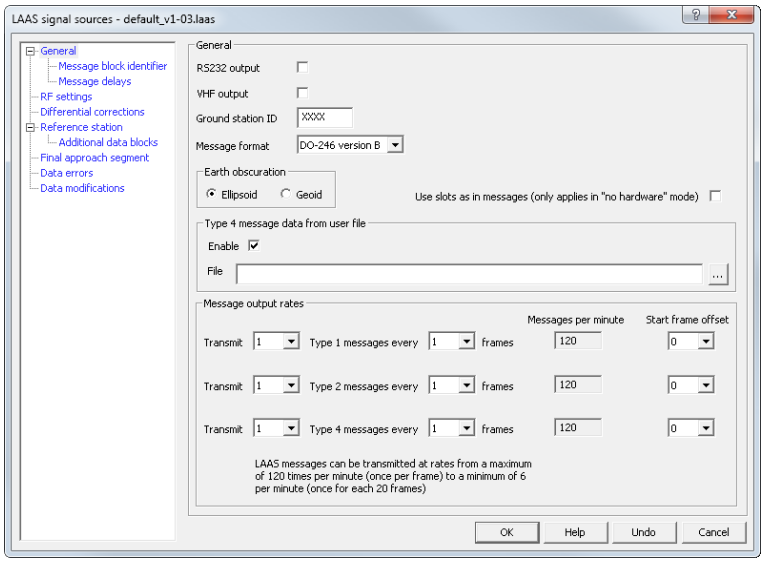

**Receive and transmit antennas-*Transmitter antenna level and phase*** patterns (page 23-20) details creating and applying **Tx antenna patterns**.

→ Edit the LAAS constellation file in the same way as you would edit a GPS constellation file. First, expand **LAAS constellation**. Then:

→ Select **LAAS constellation-Signal sources file**

→ Right-click and select **Edit**

→ You will see the **Signal sources-General** dialog, shown below. The LAAS signal sources file has the default name, *default_vx-yy.laas* and uses **Message format-DO-246 version B** as default.




The left-hand area of the **Signal sources** dialog shows the titles of all “pages” you can edit in the file. Click on a title to edit it.

After editing the **Signal sources file**, click **OK** then save the file to a name of your choice using the dialog. Select **Shared** to save this file to the shared folder, so making it available to other scenarios.

## 15.2 Message scheduling

***Notes:***

***1)*** *A maximum of five blocks can fit into one slot*

***2)*** *If the number of FAS blocks per message is not a multiple of the number of FAS blocks, SimGEN cycles the blocks. For example, for five blocks, two per message; the blocks transmitted are 1+2 3+4 5+1 2+3 4+5 1+2 3+4 and so on.*

***3)*** *You must ensure the Message rate is not a multiple of (blocks/blocks per message).*

***4)*** *If you select different messages per frame rate, you must determine if a conflict may occur*

As well as determining the message per frame rate, you can also use **LAAS definition-Signal sources file-General-Start frame offset** to avoid messages conflicting for the same time slot. To do this you must apply an appropriate offset and ensure the messages per frame have the same rate.

Use a value from the drop-down in **LAAS definition-Signal sources file-Final approach segment-Number of FAS blocks per message** to configure transmission of available FAS data blocks. The available range is 1 to 5.

For example:


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If there are four FAS blocks and you set:

**Final approach segment-Number of FAS blocks per message=2**

**General-Transmit=1 Type 4 message every=10 frames**

Then:

- at T= 5 SimGEN transmits a Type 4 message with FAS blocks 1 and 2
- at T=10 FAS 3 and 4,
- at T=15 FAS 1 and 2 and so on.

## 15.3 Slot scheduling

***Note**: Currently, Spirent supports multi-slot messages only in "no hardware" mode. You can select a message to run in different **Broadcast slot numbers**, but currently, you cannot run more than one message in different **Broadcast slot numbers** on a signal generator.*

You can specify the **Broadcast slot number** (as values A to H) in **LAAS definition-Signal sources file-Differential corrections**, **-Reference station** and **-Final approach segment**. This is the slot number in which SimGEN broadcasts the data. SimGEN can transmit a message in the same slot, or in different slots. SimGEN uses the following algorithm when it transmits all data in the same slot and the resulting data is too big:

- At the start of a run, SimGEN can assign a transmission rate and an offset to each message.
- SimGEN adds the messages and loads them into a counter.
- The counter decrements each frame for each message type. When the counter reaches zero that message is set as pending.
  After sending a message, the counter resets to the appropriate rate value.
- Messages transmission is in the order: Type1 then Type2 then Type4.
- Suppression of a Type1 message only if either of the other types has been suppressed for two frames.
- Suppression of a Type2 message if there is insufficient space in the frame after sending a Type1 message, or if a Type4 message has been suppressed longer than the Type2 message.
- It suppresses a Type4 message if there is not sufficient space in the frame after sending the Type1 and/or Type2 messages.

### 15.3.1 Slot scheduling - Filling all unused data slots

***Notes:***

***1)** If Type 2 or 4 messages are in the same slot as Type 1, SimGEN places the full message (Type 1 plus 2 and/or 4) in the unused slots.*

***2)** The **Station Slot Identifier** is identical across all slots containing Message Type 1. The initial Message Type 1 slot position determines the Identifier. For example, if the slot for Type 1 messages is E, the "Station Slot Identifier" field in the message is set to "E" for the messages in unused slots A, B etc. (See Note 3)*

***3)** Following reference f), where SimGEN specifies multiple messages for transmission in different time slots, SimGEN transmits all the messages with the same **Station Slot Identifier** in their training sequence section.*

***4)** If the message rates are such that no message type appears in one frame, SimGEN fills that frame with unspecified data.*

Selecting **RF settings-Fill all Unused Data Slots** fills all unused slots with a repeat of the message data that appears in the first slot of that frame. This feature simulates data being present in all slots.

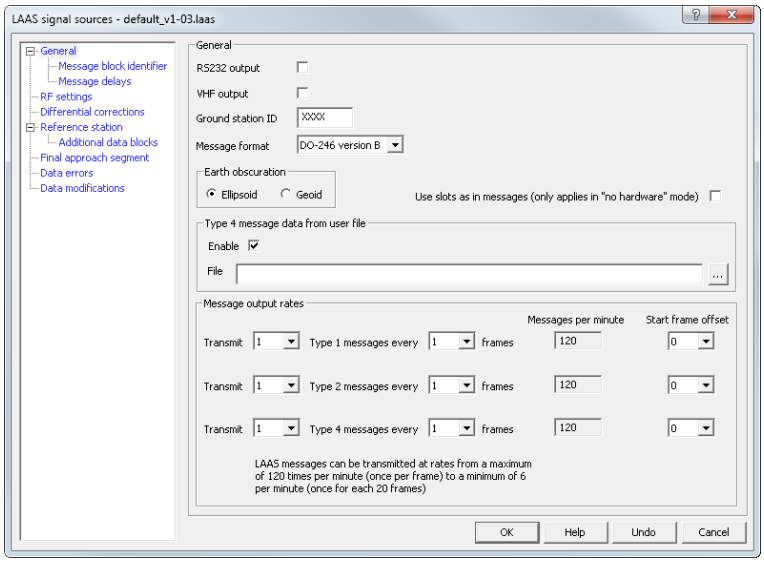
The **Station Slot Identifier** is the Broadcast Slot number of the first message transmitted in the frame.


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## 15.4 General

***Note**: See the reference documents f), g)and h) for further details on these parameters.*

This figure shows the **General** dialog.




| | | | |
|---|---|---|---|
| **RS232 Output** | Deselect (default): RS-232 port not in use<br>Select: uses the RS232 output.<br>The menu item **Options-*RS-232 port settings*** (page 5-28) describes configuring the RS232 port. | | |
| **VHF Output** | Deselect (default): does not use VHF output<br>Select: uses VHF output (and turns ON the GSS4150 front panel ACTIVE indicator) | | |
| ***Note**: VHF output is only available if a GSS4150 is present in the configuration.* | | | |
| **Ground Station ID** | Units: none | Range: four (mixed) alphanumeric digits | Default: XXXX |
| **Message format** | Choose from:<br>**DO-246 version B** (default) - enables **Reference station-Additional data blocks-Use block 1**<br>**DO-246 version A** (does not use additional data blocks)<br>**DO-246 version C**- enables **Reference station-Additional data blocks-Use block 1** (then **Use block 3** and **Use block 4**) | | |
| **Earth obscuration** | Choose from WGS84 **Ellipsoid** (default) or the local value for the **Geoid**. | | |
| **Use slots as in message mode (only applies in “no hardware” mode)** | Deselect (default): run one message in different Broadcast slot numbers (use when running SimGEN with a signal generator)<br>Select: runs more than one message in different Broadcast slot numbers in “no hardware” mode | | |
| ***Note**: Currently, Spirent supports multi-slot messages only in “no hardware” mode. You can select a message to run in different **Broadcast slot numbers**, but currently, you cannot run more than one message in different **Broadcast slot numbers** on a signal generator.* | | | |
| **Type 4 message data from user file** (notice **Message output rates** also applies to Type 4 messages) | | | |
| **Enable** | Deselect (default): Do not use Type 4 message data from file<br>Select: Use Type 4 message data from file. ***Type 4 Message file format*** (page 15-5) describes the format of the Type 4 message file. | | |
| **File** | Click **…** and navigate to the location of your Type 4 message file | | |


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| | |
|---|---|
| **Message output rates** | Schedule the frequency of LAAS messages see ***LAAS constellation editor*** (page 15-1) and ***Message scheduling*** (page 15-2) |

### 15.4.1 Type 4 Message file format

***Note**: Currently, Spirent only supports Message type 4 - see reference h), from file.*

All Type 4 message files you create must have the format shown in the following example file. The first message in the example is the example from Table B-5 in Appendix B of reference h):

```
// Example Type 4 Message file using details from RTCA DO-246D,
//Appendix B, Table B-5
CRC_INCLUDED FALSE
TYPE 4
TIME 0
LENGTH 1072
55D1850C20519400D06050D0B390C080CC8C30D1254E88ADFEAA07837F1C397FD908C0438034802600B48
C6F6E2613EA80A8047028E0200030FB1E8CC4DB4B526828C832809CA962803069918CCB874B526822A220
581CC9428030FF798C26574BFFFF3042AC20A4C602400802C58CE62F4B771035C052DF91C6A850508802C
0FBAB280E2613
TYPE 4
TIME 20
LENGTH 280
A1AFDCE234567910FEABACED34121287867234230489789789743423789342349872 37
TYPE 4
TIME 40
LENGTH 280
0123456789012345678901234567890123456789012345678901234567890123456789
.
.
.
.
```

You must keep the order of entries (other than comment lines) as shown in the example above. This table defines the entries:

| Entry | Comment |
|---|---|
| // | Denotes a comment line. |
| CRC_INCLUDED | (mandatory) The last 32 bits in the message contain the CRC keyword.<br>Must be either:<br>CRC_INCLUDED FALSE - message does not include CRC keyword<br>CRC_INCLUDED TRUE - message includes CRC keyword<br>CRC_INCLUDED applies to all messages in this file |
| TYPE 4 | (mandatory) Denotes a Type 4 message |
| TIME | (mandatory) The time of applicability (seconds from start of run) of the following Type 4 message. In the example above, zero refers to the start of the scenario |
| LENGTH | (mandatory) The number of bits in the message.<br>If you use CRC_INCLUDED TRUE, this must include the correctly calculated 32 bits of the message CRC |
| message data | Hexadecimal message data, 4 bits per character.<br>The example file above shows the long hexadecimal data message wrapped over several lines. Each hexadecimal data message in the file you create must be continuous and terminated by a single <CR><LF>.<br>Do not use multiple lines in the message data. |

Normally, you would send only one Type 4 message; however, if your file contains more than one message, SimGEN applies the messages when next scheduled, on or after the time you specify. SimGEN continues to send a message until you specify a further message.

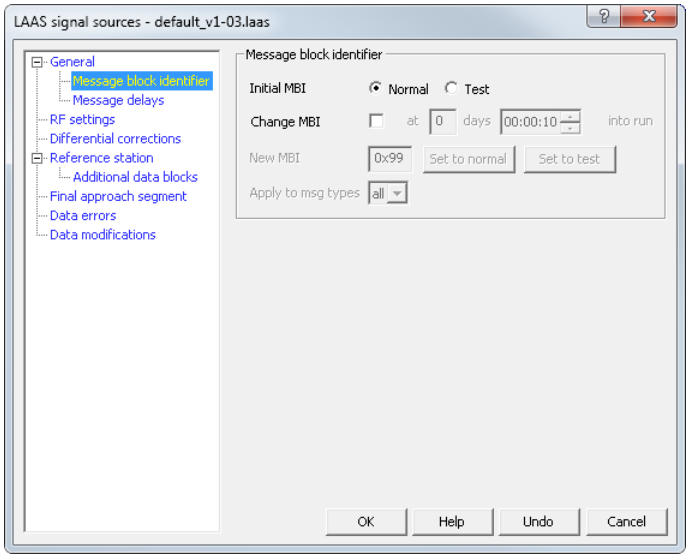

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As shown in the example file above, you must precede each message with TYPE, TIME and LENGTH.

You must use the file extension **.laas_msg*.
Spirent recommends you store this file in a convenient location, for example the *Shared* folder.

## 15.4.2 General - Message block identifier

Use this dialog set the initial Message Block Identifier (MBI).

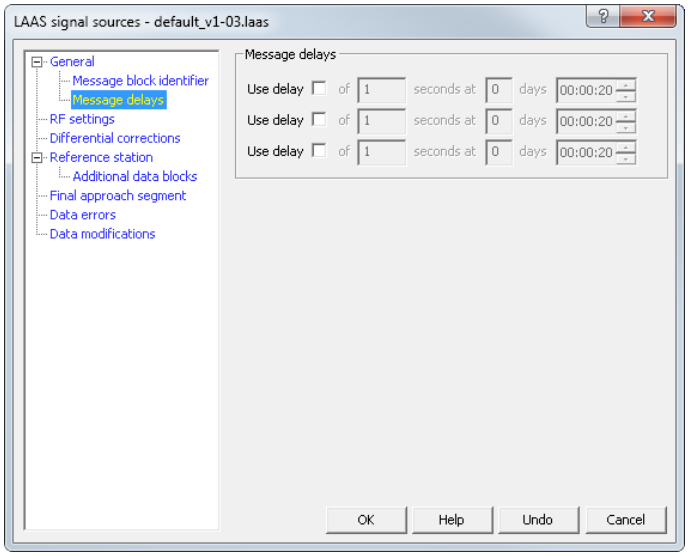



| | | | |
|---|---|---|---|
| **Initial MBI** | Choose the Initial Message Block Identifier in all messages from: **Normal** (MBI = 0xAA) (default)<br>**Test** (MBI = 0xFF) | | |
| **Change MBI** | Deselect (default): MBI does not change<br>Select: change the **initial MBI** to the **New MBI** at time **into run** | | |
| (Time) **into run** | Units: d hh:mm:ss | Range: 0 00;00:00 to 23 23:59:59 | Default: 0 00:00:10 |
| **New MBI** | Enter an arbitrary eight-bit hexadecimal number, or:<br>Click **Set to normal** to set MBI = 0xAA<br>Click **Set to test** to set MBI = 0xFF | | |
| **Apply to msg types** | Choose from **all** (default), **1**, **2**, **4** | | |


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### 15.4.2.1 General - Message delays

Use this dialog to delay the LAAS messages.



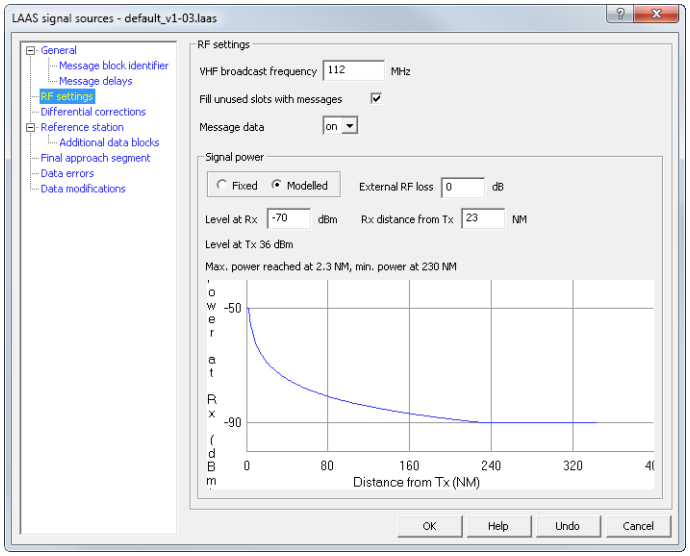

| | | | |
|---|---|---|---|
| **Use delay** | Deselect (default): do not use a Message delay<br>Select: use delay set as **seconds** delay **at** a time into run.<br>You can set up to three separate delays | | |
| **seconds** | Units: seconds | Range: 0 to 15 s in 0.5 s increments | Default: 1 |
| ***Notes**:*<br>***1)** Each 0.5-seconds increment in* **Delay** *corresponds to one transmission slot, see the example in the following table.*<br>***2)** So that no gaps occur in transmission, SimGEN transmits "old" data to achieve the required delay.* | | | |
| **at** | Units: d hh:mm:ss | Range: 0 00:00:00<br>to 23 23:59:59 | Default: 0 00:00:20 |

| Time | Time of validity of transmitted message | Delay | Time | Time of validity of transmitted message | Delay |
|---|---|---|---|---|---|
| 0 | 0 | 0 | 2.0 | 2.0 | 0 |
| 0.5 | 0.5 | 0 | 2.5 | 2.0 | 0.5 |
| 1.0 | 1.0 | 0 | 3.0 | 2.0 | 1.0 |
| 1.5 | 1.5 | 0 | 3.5 | 2.5 | 1.0 |


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### 15.4.3 RF settings

Use this dialog to configure the GSS4150 VHF Data Broadcast Generator. It shows a graph of Received power plotted against distance and shows the distances where you will reach maximum and minimum power.




| | | | |
|---|---|---|---|
| **VHF broadcast frequency** | Units: Megahertz | Range: 108.000 to 117.975 MHz | Default: 112 |
| **Fill unused slots with messages** | Deselect (default): do not fill unused slots with messages<br>Select: fill unused slots with messages, see ***Slot scheduling - Filling all unused data slots*** (page 15-3). | | |
| **Message data** | Choose from **on** (default) or **off** | | |
| **Signal power** | Use with **External RF loss** to position the 40 dB dynamic power range of the GSS4150 | | |
| | Choose from:<br>**Modelled** (default): the GSS4150 varies the signal level in response to the separation distance of the simulated transmitter location and the simulated vehicle position, and in response to the simulated VHF antenna reception pattern,<br>**Fixed**: maintains constant power. | | |
| **External RF loss** | Use to compensate the GSS4150 for external RF losses<br>Use with **Signal power** to position the 40 dB dynamic power range of the GSS4150 | | |
| | Units: decibel | Range: 0 to 9 dB (0.5 dB steps) | Default: 0 |
| ***Note**: The GSS4150 power level will limit if you exceed its maximum / minimum power.* | | | |
| **Level at Rx** | Units: dBm (decibel referred to 1 mW) | Range: -50.0 to -90 dBm | Default: -70 |
| **Rx distance from Tx** | Units: Nautical Miles | Range: none | Default: 23 |


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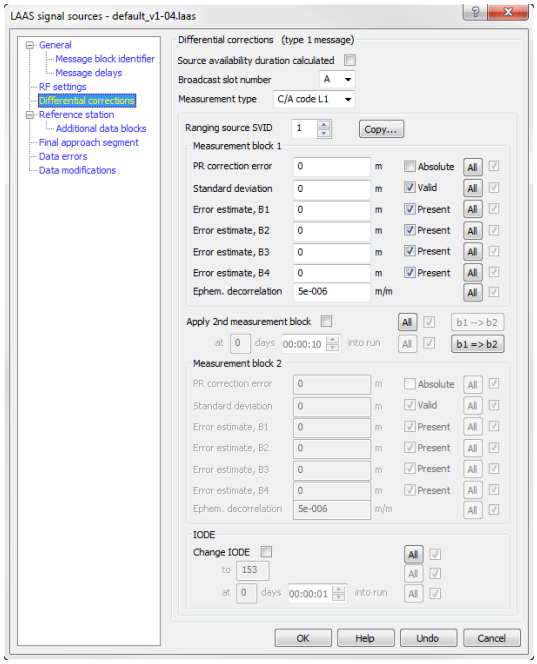
## 15.4.4 Differential corrections (type 1 message)

***Notes**:*

***1)** You can switch to a second measurement block at a designated time and change to a new broadcast IODE.*

***2)** Spirent understands the two bytes of the ephemeris CRC in message Type 1 are swapped, compared to the order in reference g). Spirent understands this reference needs amending.*

Refer to reference f) and use **Differential Corrections** to define the 'error estimate parameters' associated with each SVID.




| | | | |
|---|---|---|---|
| **Source availability duration calculated** | Deselect (default): The ground facility does not provide duration information (for all satellites)<br>Select: Duration information is calculated and provided | | |
| **Broadcast slot number** | Choose from: **A** (default) to **H** | | |
| **Measurement type** | Choose from: **C/A code L1**(default), **C/A code L2**,<br>**P(Y) code L1**, **P(Y) code L2**, | | |
| **Ranging source SVID** | Select the **SVID**.<br>Click **Copy** to copy these parameters to the SVID you select in the dialog. | | |
| For each of the following **Measurement block 1** and **Measurement block 2** parameters, click **All** to copy the current setting to all SVIDs, a tick mark confirms this. | | | |
| **PR correction error** | Units: metres | Range: ± 327.67 m | Default: 0 |
| **Absolute** | Deselect (default): Use the value you enter for **PR correction error** as an offset<br>Select: Use the value you enter for **PR correction error** as the output value | | |
| **Standard deviation** | Units: metres | Range: 0 to 5.08 m | Default: 0 |
| **Valid** | Select (default): the standard deviation is present and valid<br>Deselect: the standard deviation is present but not valid | | |
| **Error estimate B1,**<br>to<br>**Error estimate B4** | Units: metres | Range: ± 6.35 m | Default: 0 |
| **Present** | Select (default): this **Error estimate** is present<br>Deselect: this **Error estimate** is not present | | |


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| | | | |
|---|---|---|---|
| **Ephem. decorrelation** | Enabled for **2nd measurement block** only when you select **Apply 2nd measurement block** for **General-Message format-DO 246 version B** | | |
| | Units: metres per metre | Range: 0 to 0.001 275 $m.m^{-1}$ | Default: 5 E-6 |
| **Apply 2nd measurement block** (see above for parameter description) | Deselect (default): do not use the second measurement block<br>Select: use the second measurement block. Enables **b1-->b2**, **into run** and **Measurement block 2**.<br>Click **All** to apply the current **Measurement block 2** settings to all SVIDs, at the time **into run**. A tick mark confirms this.<br>Clicking **b1=>b2** copies **Measurement block 1** of each SVID to **Measurement block 2** | | |
| **at** | Units: d hh:mm:ss | Range: 0 00;00:00 to 23 23:59:59 | Default: 0 00:00:10 |
| | Click **All** to apply time **into run** to all SVIDs. A tick mark confirms this.<br>Click **b1-->b2** to copy **Measurement block 1** of this SVID to **Measurement block 2** for this SVID | | |
| **Change IODE** | Deselect (default): Change IODE is not used<br>Select: Change IODE to the number at the time **into run**<br>Click **All** to select **Change IODE** on all SVIDs. A tick mark confirms this. | | |
| **to** | Units: none | Range: 0 to 255 | Default: 153 |
| | Click **All** to use this value of IODE for all SVIDs. A tick mark confirms this. | | |
| **at** | Units: d hh:mm:ss | Range: 0 00:00:00 to 23 23:59:59 | Default: 0 00:00:01 |
| | Click **All** to use this time **into run** for all SVIDs. A tick mark confirms this. | | |

Clicking **All** displays a dialog requesting you confirm you want to make the setting for all SVIDs.

### 15.4.5 Reference station (type 2 message)

***Notes**:*

***1)** You can apply a second value of the **Continuity/Integrity Designator** parameter at a designated time. From that time on, this data will replace the original data in the type 2 message.*

***2)** Spirent understands the encoding description in reference g) for the (tropospheric) Refractivity index in message Type 2 is ambiguous. Spirent uses the following coding:*

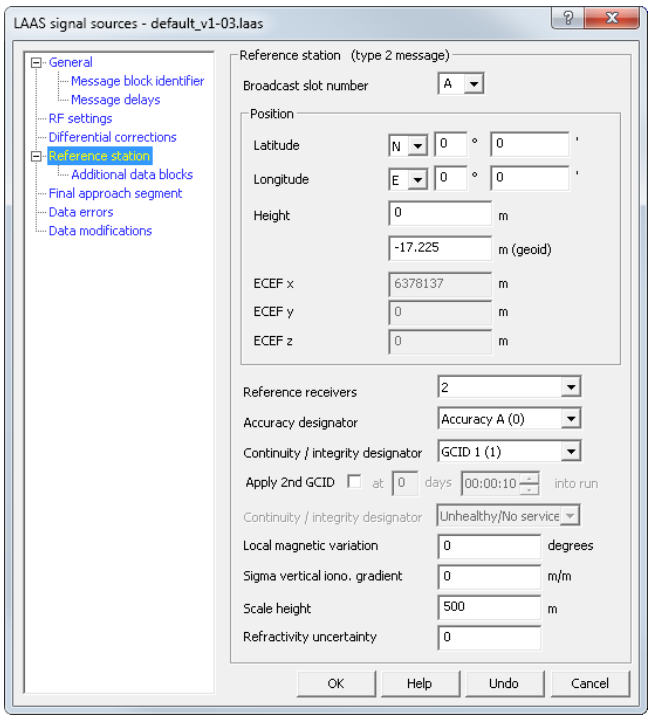
*int encoded_refractivity = nint((calculated_refractivity_d - 400.0) / 3.0).*

*The resulting value is truncated if >127 or < -128*

Refer to the appropriate document - see references f) and g), and use this dialog to define the attributes of the LAAS transmitter. The LAAS transmitter must be visible at the vehicle's antenna for SimGEN to generate LAAS broadcast data.

When you define a location for a reference receiver, SimGEN determines the errors to apply to the simulated satellite signal. These include Ionosphere, Satellite Clock terms, Clock Noise (simulated Selective Availability) and Ephemeris errors.


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| | | | |
|---|---|---|---|
| **Broadcast slot number** | Choose from **A** (default) to **H** | | |
| **Position** | Enter the reference station position | | |
| **Latitude** | Units: degrees, minutes | Range: N 90° 0’ to S 90° 0´ | |
| **Longitude** | Units: degrees, minutes | Range: E 180° 0.0´ to W 180° 0.0´ | |
| **Height** | Units: metres | Range: ± 83 886.07 m | Default: 0 (-18 for geoid) |
| **X position (ECEF)**<br>**Y position (ECEF)**<br>**Z position (ECEF)** | SimGEN calculates the ECEF co-ordinates using **latitude**, **longitude** and **height**. | | |
| **Reference receivers** | Choose from **2** (default), **3** or **4** | | |
| **Accuracy designator** | Choose from **Accuracy A(0)** (default), **Accuracy B (1)**, **Accuracy C (2)** or **Spare (3)** | | |
| **Continuity / integrity designator** | Choose from Reserved (0), **GCID1 (1)** (default), **GCID 2 (2)** to **GCID 4 (4)**, **Reserved (5)**, **Reserved (6)** and **Unhealthy/No service (7)** | | |
| **Apply 2nd GCID** | Deselect (default): does not apply second GCID<br>Select: applies second GCID at the time into run you enter | | |
| **at** | Units:<br>d hh:mm:ss | Range: 0 00;00:00<br>to 23 23:59:59 | Default: 0 00:00:10 |
| **Continuity / integrity designator** (second, see above for parameter details) | **Unhealthy/No service (7)** (default) | | |
| **Local magnetic variation** | Units: degrees | Range: ± 180° | Default: 0 |
| **Sigma vertical iono gradient** | Enabled in **General-Message format-DO 246 version B** only | | |
| | Units: metres per metre | Range: 0<br>to 2.55 E -5 $m.m^{-1}$ | Default: 0 |
| **Scale height** | Units: metres | Range: 0 to 25 500 m | Default: 500 |
| **Refractivity uncertainty** | Units: none | Range: 0 to 255 | Default: 0 |


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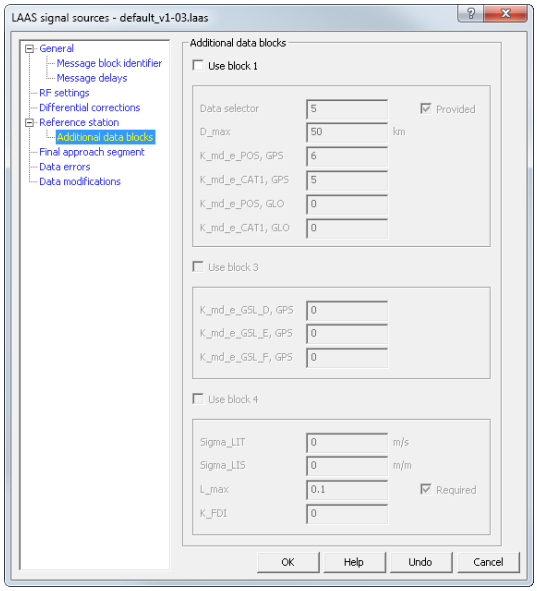
### 15.4.5.1 Additional data blocks

***Note**: References f) and g) give further details on these parameters.*

This table details the **Additional data block** availability, which depends on the **Message format** you use:

| DO-246<br>Message format | Additional data block availability |
|---|---|
| Version A | Not available |
| Version B | Enables **Use block 1** only |
| Version C | Enables **Use block 1**<br>Selecting **Use block 1** then enables **Use block 3** and **Use block 4** |

The **General-Message format** dialog:




| | | | |
|---|---|---|---|
| **Use block 1** | Deselect (default): do not use block 1<br>Select: Enables the block 1 parameter area | | |
| **Data selector** | Units: none | Range: 0 to 48 | Default: 5 |
| **Provided** | Select (default): enables **Data selector**.<br>Deselect: disables **Data selector** and transmits message “Positioning service not provided” | | |
| **D_max** | Units: kilometres | Range: 2 to 510 | Default: 50 |
| **K_md_e_POS, GPS,**<br>**K_md_e_CAT1, GPS,**<br>**K_md_e_POS, GLO,**<br>**K_md_e_CAT1, GLO** | Units: none | Range: 0 to 12.75 | Default: 6<br>Default: 5<br>Default: 0<br>Default: 0 |
| **Use block 3** | The table above details the conditions to enable this area<br><br>Deselect (default): do not use block 3<br>Select: Enables the block 3 parameter area | | |
| **K_md_e_GSL_D, GPS,**<br>**K_md_e_GSL_E, GPS,**<br>**K_md_e_GSL_F, GPS,** | Units: none | Range: 0 to 12.75 | Default: 0<br>Default: 0<br>Default: 0 |


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| | | | |
|---|---|---|---|
| **Use block 4** | The table above details the conditions to enable this area<br><br>Deselect (default): do not use block 4<br>Select: Enables the block 4 parameter area | | |
| **Sigma_LIT** | Units: metres per second | Range:<br>0 to 0.025 5 $m.s^{-1}$ | Default: 0 |
| **Sigma_LIS** | Units: metres per metre | Range:<br>0 to 0.025 5 $m.m^{-1}$ | Default: 0 |
| **L-max** | Units: none | Range: 0.1 to 12.75 | Default: 0.1 |
| **Required** | Select (default): enables **L-max**.<br>Deselect: disables **L-max** as no additional geometry constraint is needed | | |
| **K_FDI** | Units: none | Range: 0 to 12.75 | Default: 0 |

### 15.4.6 Final Approach Segment (FAS) (message type 4)

***Notes**:*

***1)** References f) and g) give further details on these parameters.*

***2)** According to reference h), Type 4 messages can contain FAS and/or TAP (terminal approach path) messages, Currently Spirent supports TAP messages using **General-Type 4 message data from user file***

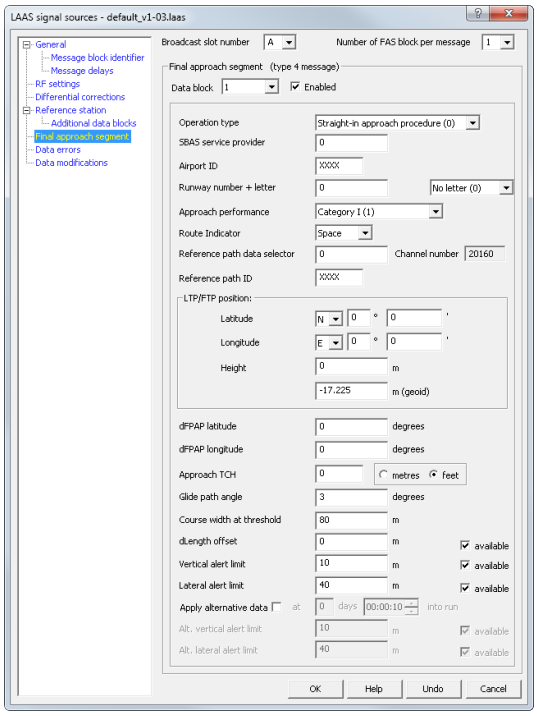
***3)** If you select **General-Type 4 message data from user file**, SimGEN will not use data from this dialog.*

Use this dialog to define the contents of Message Type 4. You can define up to five different FAS data blocks.

SimGEN will use the **Broadcast slot number** parameter from this dialog (as this is part of the message header) when you:

→ Select **Use slots as in messages (only applies in "no hardware" mode)**

→ Run SimGEN in "no hardware mode, see ***Control Options*-No hardware ("dummy run")** (page 5-13)




| | |
|---|---|
| **Broadcast slot number** | Choose from **A** (default) to **H** |


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| | | | |
|---|---|---|---|
| **Number of FAS block per message** | Choose from **1** (default) to **5** | | |
| **Final approach segment** | | | |
| **Data block** | Choose from **1** (default) to **5** | | |
| **Enabled** | Deselect (default): Type 4 message not used<br>Select: uses Type 4 message | | |
| **Operation type** | Choose from: **Straight-in approach procedure (0)** (default) or **Spare (1)** to **Spare (15)** | | |
| **SBAS service provider** | Currently SimGEN does not support this feature | | |
| **Airport ID** | Type a minimum 3-digit alphanumeric ID | | |
| **Runway number and letter** | Type the runway number<br>Choose the letter from **No letter (0)** (default), [**R**]**ight (1)**, [**C**]**entre (2)**, **[L]eft (3)** | | |
| **number** | Units: none | Range: 0 to 36 | Default: 0 |
| **Approach performance**, **Route indicator** | Choose from the items in the drop-down menu | | |
| **Reference path data selector** | Units: none | Range: 0 to 48 | Default: 0 |
| **Reference path ID** | Type a minimum 3-digit alphanumeric ID | | |
| **LTP/FTP position** | | | |
| **Latitude** | Units: degrees, minutes | Range: N 90° 0’ to S 90° 0´ | |
| **Longitude** | Units: degrees, minutes | Range: E 180° 0.0´ to W 180° 0.0´ | |
| **Height** | Units: metres | Range: -512 to 6 041.5 m | Default: 0<br>(-18 for geoid) |
| **dFPAP latitude**<br>**dFPAP longitude** | Units: degrees | Range: ± 1° | Default: 0 |
| **Approach TCH** | Units: select **feet** (default) or **metres** | Range: 0 to 3 276.7 feet | Default: 0 |
| **Glide path angle** | Units: degrees | Range: 0 to 90° | Default: 3 |
| **Course width at threshold** | Units: metres | Range: 80 to 143.75 m | Default: 80 |
| **available** | Select to make available each of the following parameters | | |
| **dLength offset** | Units: metres | Range: 0 to 2 032 m | Default: 80 |
| **Vertical alert limit**<br>**Alt. vertical alert limit** | Units: metres | Range: 0 to 25.4 m | Default: 10 |
| **Lateral alert limit**<br>**Alt. lateral alert limit** | Units: metres | Range: 0 to 50.8 m | Default: 40 |
| **Apply alternative data** | Enables **time into run**, **Alt. vertical alert limit** and **Alt. lateral alert limit** | | |
| **Time into run** | Units:<br>d hh:mm:ss | Range: 0 00;00:00<br>to 23 23:59:59 | Default: 0 00:00:10 |
| **available** | Select to make available **Alt vertical** and **Alt lateral** | | |


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## 15.4.7 Data errors and modifications

***Notes***:

***1)*** *Spirent recommends you only apply errors to, or modify, existing messages. First run your scenario without applying* ***Data errors****, or* ***Data modification,*** *then apply* ***Data errors*** *or* ***Data modification*** *to the messages this scenario produces.*

***2)*** *SimGEN does not check the content of any messages and applies the message "as is". SimGEN applies the correct CRC and FEC to all messages. If you modify fields that are not in an existing message, you risk corrupting the entire message.*

***3)*** *LAAS fields are LSB first and you MUST enter your modifications LSB first.*
*This applies where there are two fields in one 8-bit stream such as runway number (6-bits) and letter (2-bits). Enter the 6-bit runway number LSB first followed by the 2-bit runway letter LSB first*

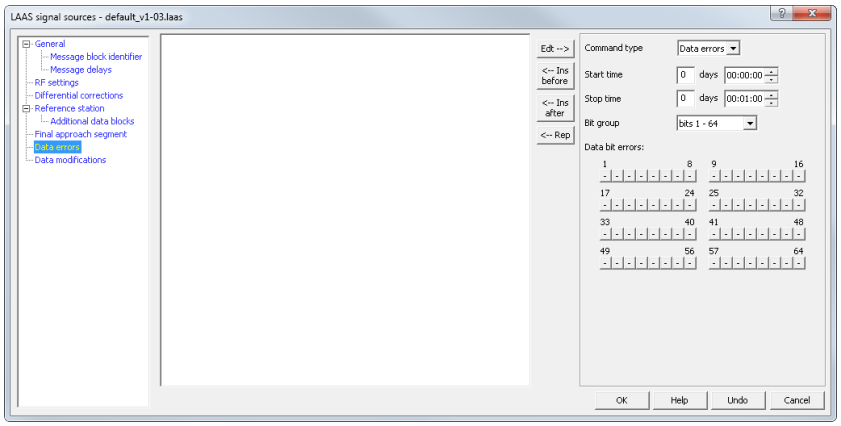
***4)*** *You must manually build the Command file list in the order you want. SimGEN does not automatically order these actions.*

***5)*** *Currently, SimGEN only supports* ***Command type - Data errors.***

***6)*** *Data errors and modifications do not apply to* ***General****-****Type 4 message data from user file***

***7)*** *To see the Data errors and modifications Help file entries for this constellation, Spirent recommend you select the Help topic from the* ***SimGEN Help-Contents*** *tab; clicking* ***Help*** *or pressing F1 on your keyboard may display an invalid Help topic.*

You can manipulate any data bit in any data frame to simulate 'over the air' transmission errors using the SimGEN ***List Editor*** (page 5-33):




| | | | |
|---|---|---|---|
| **Start time**<br>**Stop time** | Units:<br>d hh:mm:ss | Range:<br>0 days 00:00:00<br>to 23 days 23:59:59 | **Start** default:<br>0 days 00:00:00 (start of run)<br>**Stop** default:<br>0 days 00:01:00 |
| **Bit group** | Select the bit group you want to modify | | |
| **Data bit errors** | Apply an error to any of the data bits by first selecting the **Bit group** and then adding **Data bit errors** using the buttons.<br>This table (page 10-16) details the symbols on each button.<br>The default is "leave bit as is".<br>The figure above shows bits 3 to 6 have been set to **0000**.<br><br>***Note****: Spirent refers to bit numbers for ease of use and see Note 3)* | | |
| **Data bit mods** (currently not supported by SimGEN) | Modify any of the data bits by first selecting the **Bit group** and then introducing **Data bit mods** using the buttons.<br>This table (page 10-16) details the symbols on each button.<br>The default is "leave bit as is".<br><br>The number of buttons depends on the **Command type** you select | | |


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## 15.5 Data diagnostic files

SimGEN can log LAAS output data to files as your scenario runs. SimGEN saves the files into the folder that holds the simulation definition files and replaces these data files each time you run the scenario. After you run each scenario, you must save the data files in another folder or rename them if you need to retain a particular file.

Enable data diagnostic files by selecting menu item **Options-*General Options* -Dump navigation data** (page 5-15).

This table details the data diagnostic files.

| Filename | Description |
|---|---|
| *vdbdata.dat* | The bit-stream data file of the GSS4150 LAAS VHF signal generator, a 256-byte block for each frame.<br>SimGEN appends zeroes to pad the message to 256-bytes.<br>SimGEN transmits the first bit in the LSB of the first byte. |
| *rsdata.dat* | The bit-stream data file of the data transmitted on the RS232 output port, a 256-byte block for each frame.<br>The bit-stream starts with the first bit of the first Message Block Header and ends with the last bit of the last Message Block CRC.<br>This file does not have the Training Sequence or Application FEC bits and is not 'bit scrambled'. |

## 15.6 LAAS Decoder

***Note**: Spirent no longer distributes the decoder with filename LAAS_RF_decoder.exe (see **LAAS RF decoder - up to SimGEN 2-81** (page 15-18). Contact **Spirent Global Services** to obtain a copy of this decoder*

The following sections describe using the following LAAS decoders:

- → ***LAAS decoder - SimGEN version 2-82 on*** (page 15-16)
- → ***LAAS RF decoder - up to SimGEN 2-81*** (page 15-18) - see Note above

Make sure you use the correct decoder for the version of SimGEN you use to run your scenario.

### 15.6.1 LAAS decoder - SimGEN version 2-82 on

***Notes**:*

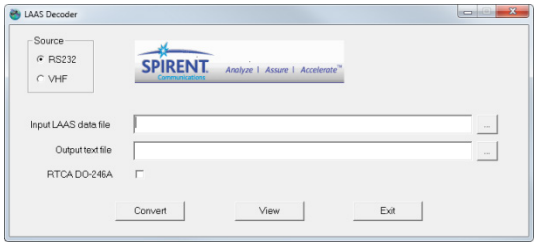
***1)** This decoder WILL NOT decode vdbdata.dat files produced by SimGEN up to version 2-81. To decode these files, use **LAAS RF decoder - up to SimGEN 2-81** (page 15-18).*

***2)** At least 18 seconds of elapsed simulation time must pass before you can be certain that all satellite CRC values are non-zero*

***3)** The decoder will decode data from **General**-**Type 4 message data from user file**. However, the decoder will only decode FAS messages that precede TAP messages. The decoder correctly shows the checksum/CRC for **Type 4 messages from user file**.*

Use this decoder to decode and display the data diagnostic files *vdbdata.dat* and *rsdata.dat* file created by SimGEN version 2-82 onwards.

To open the decoder, navigate to the *SimGEN* folder on your SimGEN Controller (default location *C:\Program Files\Spirent Communications\Positioning Application*) and double-click *LAAS_decoder.exe:*





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| | |
|---|---|
| **Source** | Select the source of the LAAS data file you want to decode from:<br>**RS232** (default): decodes the file *rsdata.dat* for all versions of SimGEN, see Note 1) above<br>VHF: decodes the file *vdbdata.dat* only for SimGEN version 2-82 onward, see Note 2) above |
| **Input LAAS data file** | Click **Browse** to the right of the text area and navigate to the location of the LAAS data file you selected in **Source**. |
| **Output text file** | Click **Browse** to the right of the text area and navigate to the location where you want to store the decoded text file.<br><br>If you use **Source-RS232**:<br>The output text file shows the messages in time sequence. It labels each field and shows them decoded and scaled using plain hexadecimal.<br><br>If you use **Source-VHF**:<br>The output text file shows data (with bits displayed LSB first) using:<br>- burst unscrambled header data (decoded),<br>- burst transmission sequence (in bits),<br>- scrambled and descrambled streams (in Hex),<br>- (partially) decoded headers of the messages in the burst,<br>- D8PSK symbols<br>- burst counter.<br><br>See the (reduced length) example code below. |
| **RTCA-DO-246A** | Provides backwards compatibility<br>Deselect (default): Use RTCA-DO-246C<br>Select: Use RTCA-DO-246A |
| **Convert** | Click to parse the file you selected in **Input LAAS data file** |
| **View** | Click to display the decoded file in Windows WordPad. |
| **Exit** | Click to exit the decoder |

Example (reduced length) code from **Source-VHF**:

```
Power stabilisation: 0000 0000 0000 000
Sync: 0000 1001 1110 0000 0110 1110 0011 0001 1111 1011 1110 0010
Station slot ID: 000  (A)
Transmission length (bits): 0001 0011 1010 0000 0    (1480)
Training sequence FEC: 0011 1
Transmission sequence:
0101 0101 0001 1000 0110 0001 1000 0110 1000 0000 0111 1010 0110 1011 0111 0100
1110 0001 1000 0000
.
.

Scrambled stream (Hex):

First bit: 0
22 DF 8F 1F 07 79 AD 5F E0 BE AD D3 5C 46 D0 09 01 09 5B 23 04 2F F0 6A BF 66
54 28 8E 05 57 29 60 63 7F 7B 54 A4 5E 31
D4 9C CB 05 1B F3 DA BA D9 96 9D 76 12 E3 92 85 C6 0D 08 13 E8 7A E4 06 FF 22
.
.

Descrambled stream (Hex):

First bit: 0
04 E8 07 55 18 61 86 80 7A 6B 74 E1 80 00 00 FF C0 40 58 3F 00 00 00 00 00 00
00 A0 40 1B BF 00 00 00 00 00 00 00 90 40
C3 DF 00 00 00 00 00 00 00 30 40 FF 3F 00 00 00 00 00 00 00 08 40 64 5F 00 00
.
..
```


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```
* Message(s) in this burst:

GBAS ID: XXXX
Message type: 1
Message length (bytes): 94

GBAS ID: XXXX
Message type: 2
Message length (bytes): 34
.
.

D8PSK symbols:

0000 0035 1120 4546 3165 0072 6300 5463 3405 4064 7415 5051 7131 2021 4531 1123
3366 5357 0044 7752
7662 0305 7075 0066 5766 1727 0362 2324 6374 2032 0117 4401 5345 1346 6723 1624
.
.

* bursts count = 1
```

### 15.6.2 LAAS RF decoder - up to SimGEN 2-81

***Notes**:*

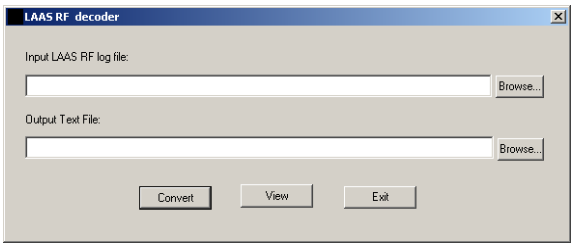
***1)** Spirent no longer distributes this decoder. Contact **Spirent Global Services** to obtain a copy of this decoder*

***2)** This decoder WILL NOT decode vdbdata.dat files produced by SimGEN version 2-82 onward. To decode these files, use **LAAS decoder - SimGEN version 2-82 on** (page 15-16).*

***3)** It takes at least 18 seconds of elapsed simulation time before all satellite CRC values are non-zero.*

Use this decoder to decode and display the data diagnostic files *vdbdata.dat* and *rsdata.dat* file created by SimGEN up to version 2-81.

This decoder decodes and displays the contents of the *vdbdata.dat* file. To open the decoder, navigate to the *SimGEN* folder on your SimGEN Controller (default location *C:\Program Files\Spirent Communications\Positioning Application*) and double-click *LAAS_RF_decoder.exe.*




| | |
|---|---|
| **Input LAAS RF log file** | Click **Browse** to the right of the text area and navigate to the location of the LAAS data file you want to decode. |
| **Output Text File** | Click **Browse** to the right of the text area and navigate to the location where you want to store the decoded text file.<br>The output shows each frame's data in sequence, displaying three forms in three separate paragraphs/lines. These three lines correspond to the sequences shown at the bottom of Table B-1 in reference g).<br><br>The first line shows the whole bit sequence in hexadecimal format. It uses two digits per 8-bit byte, with the bit order in each byte reversed enabling the bit sequence to be read left to right.<br><br>The second line is the same bit sequence but shifted to align the digits as per the "Output from Bit Scrambling" fields in Appendix B of reference g).<br><br>The third line is the bit sequence of the second line, converted to D8PSK symbols and displayed as octal digits. |


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| | |
|---|---|
| **Convert** | Click to parse the file you selected in **Input LAAS data file** |
| **View** | Click to display the decoded file in Windows WordPad. |
| **Exit** | Click to exit the decoder |


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# 16 IRNSS constellation editor

***Licenced feature**: You will need a licence to use this feature. Contact Spirent for licencing details.*

***Notes***

***1)** Currently, Spirent supports the IRNSS constellation as part of a Tailored Solution (Spirent's term for specialist, non-COTS, products and / or applications). Contact Spirent Global Services for further details*

***2)** Currently, the GSS8000-series signal generator configuration means you can only run scenarios containing the IRNSS constellation. You cannot run scenarios containing any other constellation while running IRNSS*

***3)** To enable the RS features this chapter shows as disabled, you must be an authorised user with an RS licence. Contact Spirent Global Services for details.*

The Indian Regional Navigational Satellite System (IRNSS) constellation offers a service that will extend some 1 500 km around India. The IRNSS constellation consists of seven satellites, three in geostationary orbit and four in geosynchronous orbit. All satellites will be continuously visible from India for 24 hours a day.

IRNSS offers a Standard Positioning Service and a Restricted Service. This table gives the IRNSS constellation signals, frequencies and reference levels:

| Signal | Carrier centre frequency, MHz | Power reference level, dBm |
|---|---|---|
| Standard Positioning Service (1 MHz BPSK) | L5 (1 176.45)<br>S-band (2 492.028) | -130 |

Reference v) gives the IRNSS ICD.

PosApp version 4.00 onwards supports IRNSS for GSS8000-series signal generators when using signal generator card firmware version 2-21(or later) and FPGA image release 25 (or later).

To find the firmware version and FPGA image of your signal generator cards and then determine if your signal generator needs upgrading, Spirent recommends you follow this procedure:

- Read the section on the menu item **Options-*Hardware Configuration*** (page 5-18), then display your signal generator configuration
- Select your signal generator
- Click **Output details…**
- Contact Spirent Global Services and provide the relevant details from the configuration window.
- Spirent Global Services will then determine if your signal generator needs upgrading and provide details on the upgrade procedure.

The IRNSS constellation editor is similar to the ***GPS constellation editor*** (page 10-1). If this Chapter on the IRNSS constellation editor does not give details for a scenario parameter, see the details for the parameter with the same name in the ***GPS constellation editor***.

The **IRNSS constellation-Signal sources file** characterises the IRNSS satellites in a simulation. This file is often known as the "IRNSS Constellation file", and is one of the source files defining a scenario. The default signal sources filename for the IRNSS constellation is *default_vx-yy.irn*, where *x-yy* is the version number.

This table shows the IRNSS utilities available in SimGEN:

| Utility name |
|---|
| ***IRNSS Nav Data Extract utility*** (page 26-57) |

To use the IRNSS constellation, first see **Receive and transmit antennas-*Associate a GNSS signal with an antenna*** (page 23-4) and associate the IRNSS signal with the antenna(s) you want to use.


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The upconversion process Spirent uses to generate the IRNSS signal imposes a limitation on the Doppler velocity of the vehicle. This limitation is also dependant on the Simulation iteration rate, set in ***General Options*** **-Simulation iteration rate** (page 4-15), and the IRNSS signal you choose, see the following table:

***Note**: If you first use 100 milliseconds Simulation Iteration Rate in a scenario and then change to using 10 milliseconds or 4 milliseconds, ensure you do not exceed the maximum Doppler velocities shown in the table below*

| Simulation Iteration Rate, milliseconds | Maximum Doppler velocity for S-band, $m.s^{-1}$ | Maximum Doppler velocity for L5 $m.s^{-1}$ |
|---|---|---|
| 4 | ±75 021 | ±75 021 |
| 10 | ±75 021 | ±75 021 |
| 100 | ±120 000 | ±120 000 |

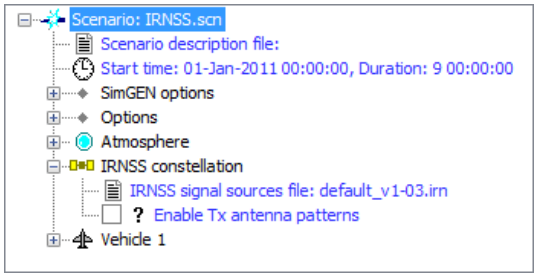
## 16.1 IRNSS constellation editor

***Note**: The range of parameter values you can enter in PosApp may be different from the values commonly used in satellite navigation systems.*

Use the constellation editor to edit data in the IRNSS constellation file. The editor shows the data in the IRNSS constellation file as a series of “pages”. The left-hand area shows the pages you can select for editing; the right-hand area shows the details of the page you selected in the left-hand area. This section describes how you select and change details in the right-hand area.

SimGEN checks the range of the value you type in a text box and, if incorrect, displays the range of acceptable values.

After associating the IRNSS signal type with an antenna, the IRNSS constellation file appears in the **Scenario contents** window:




**Receive and transmit antennas-*Transmitter antenna level and phase patterns*** (page 23-20) details creating and applying **Tx antenna patterns**.

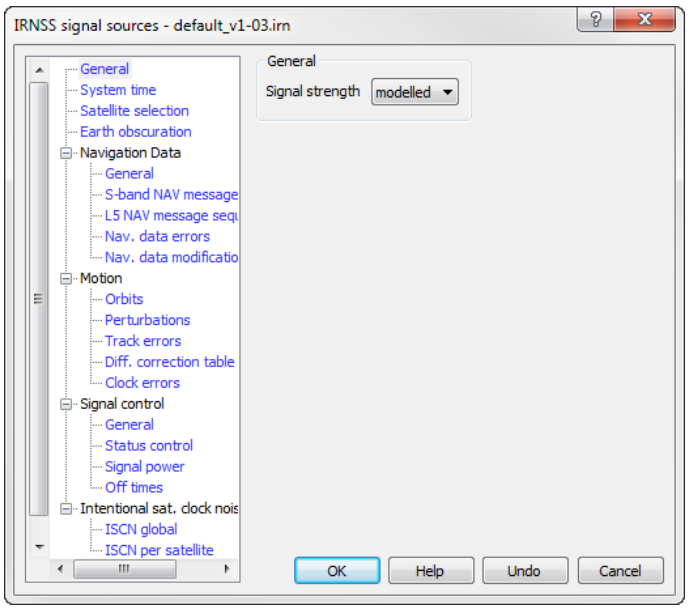
Edit the IRNSS constellation file in the same way as you would edit a GPS constellation file. First, expand **IRNSS constellation**. Then:

→ Select **IRNSS constellation-Signal sources file**

→ Right-click and select **Edit**

→ You will see the **Signal sources-General** dialog, shown below. The IRNSS signal sources file has the default name, *default_vx-yy.irn*.


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The left-hand area of the **Signal sources** dialog shows the titles of all “pages” you can edit in the file. Click on a title to edit it.

After editing the **Signal sources file** click **OK**, then save the file to a name of your choice using the dialog. Select **Shared** to save this file to the shared folder, so making it available to other scenarios.

### 16.1.1 Cutovers

For planned navigation data cutovers, SimGEN:

- Uses ephemeris and clock datasets (Subframes 1 and 2) that are valid for two hours
- Initiates a new dataset every two-hourly epoch in IRNSS system time
- Increments IODE and IODC values by one on each cutover
- Sets the values of $T_{oe}$ and $T_{oc}$ in each dataset to correspond with the cutover time
- Sets the values of $WN_a$ and $T_{oa}$ at the start of the run to correspond with the initial value of $T_{oe}$ ($T_{oc}$)

For navigation data upload cutovers, SimGEN:

- May upload new ephemeris, clock and almanac datasets at any time, but the broadcast navigation data stream only changes from the start of Subframe 1
- Sets the values of $T_{oe}$ and $T_{oc}$ in the first uploaded dataset to correspond with the cutover time for Subframe 1
- Increments IODE and IODC by one on each cutover
- If the upload time corresponds with a two-hourly epoch, SimGEN increments IODE and IODC by one on each cutover
- Sets the values of $WN_a$ and $T_{oa}$ to correspond with the $T_{oe}$ value for the first uploaded dataset

Cutovers do not affect the sequencing of Subframe 3 and 4 messages, but the new almanac data takes effect at the next Frame epoch of the upload being applied, or immediately if the Frame epoch is current.

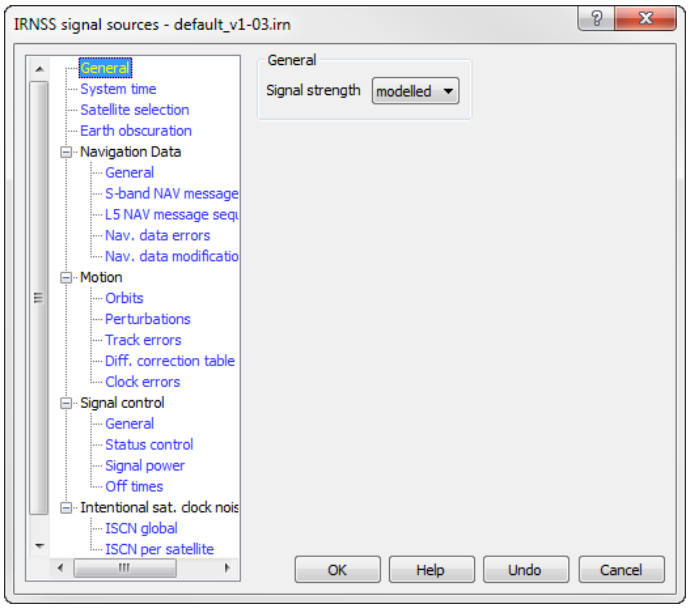
Upload/Cutover:

- At the start of run, set $T_{oa}$/$T_{oe}$/$T_{oc}$ to correspond with the previous (or current) two-hourly epoch


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## 16.2 General

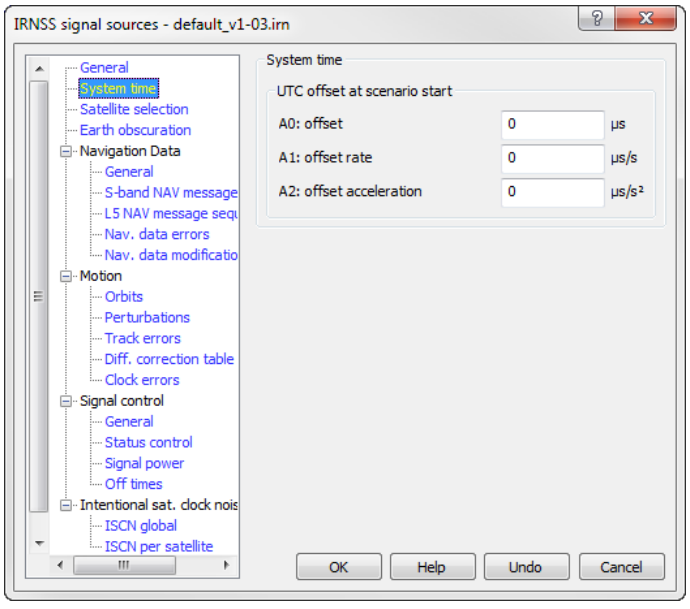
Use the **General** dialog, see below, to edit the parameters affecting all IRNSS satellites.




| | |
|---|---|
| **Signal strength** | Select whether SimGEN modifies satellite signal-levels based on satellite-to-antenna distance or uses a fixed signal level. **GPS-*General - Modelled and fixed signal strength*** (page 10-8) gives further details on Modelled and Fixed. In each case, first set the base RF power level using ***Signal control - Signal power*** (page 16-18). Choose from: |
| **Modelled** | (default) SimGEN modifies satellite signal level as a function of the satellite to receiver antenna distance in proportion to 1/(distance)$^2$ |
| **Fixed** | SimGEN does not modify the signal level as a function of satellite to receiver antenna distance. |

## 16.3 System time

Set the UTC offset parameters using this dialog:





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| | | | |
|---|---|---|---|
| **UTC offset at scenario start** | Enter the UTC offset parameters at the scenario start time. This determines the offset of IRNSS system time with respect to UTC, in addition to any leap seconds. The update times for the broadcast UTC data will correspond with the almanac update times. | | |
| **A0: offset** | Units: microsecond | Range: ±100 µs | Default: 0 |
| **A1: offset rate** | Units: microsecond per second | Range: ±0.007 4 $\mu s.s^{-1}$ | Default: 0 |
| **A2: offset acceleration** | Units: microsecond per $(second)^2$ | Range: -2.17E-13 to +2.13E-13 $\mu s.s^{-2}$ | Default: 0 |

## 16.4 Satellite selection

This dialog is the same as the **GPS-*Satellite selection*** (page 10-10).

## 16.5 Earth obscuration

This dialog is the same as the **GPS-*Earth obscuration*** (page 10-11).

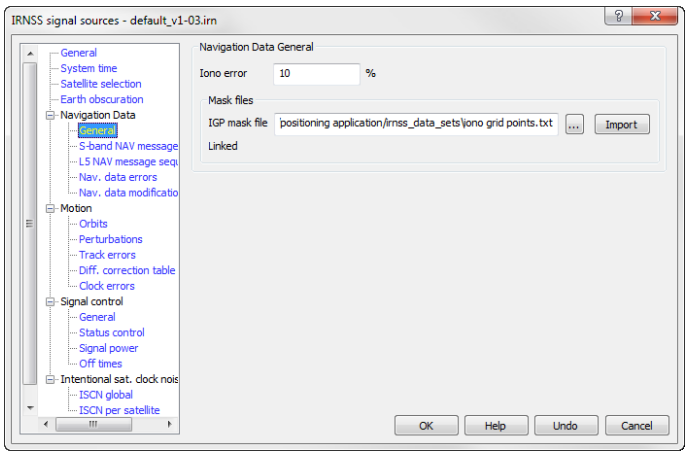
## 16.6 Navigation Data

You can apply Navigation data errors and modifications to both S-band and L5 or individually, see the following table:

| Type | Section |
|---|---|
| Errors in atmospheric delay measurements | ***General*** |
| Message sequences | ***S-band NAV and L5 NAV message sequence*** |
| Navigation data error on both S-band and L5 | ***S-L5 NAV Data Error*** |
| Navigation data error separately on S-band and L5 | ***S-band and L5 NAV Data Error*** |
| Navigation data modification on both S-band and L5 | ***S-L5 NAV Data S/F 1/2 Mod*** |
| Navigation data modification separately on S-band and L5 | ***S-band and L5 NAV Data S/F 3/4 Mod*** |

### 16.6.1 General

Use the **General** dialog to set ionospheric errors. These errors use the Klobuchar model with an Ionospheric Grid Point (IGP) mask file.




***Terrestrial iono model - IRNSS model*** (page 9-7) describes an alternative ionospheric model using a grid based ionospheric model.

| | | | |
|---|---|---|---|
| **Iono error** | Defines the percentage error SimGEN applies to all atmospheric delay measurements. SimGEN uses this to determine GIVEI indexes at each iono monitoring point in use.<br>0% shows a high confidence in the error, 100% shows a low confidence in the error. | | |
| | Units: percent | Range: 0 to 100 % | Default: 10 |
| **Mask files** | Select the file defining the locations of the valid points in the IRNSS Ionospheric Grid Mask.<br>Click the browse button, … and navigate to the location of the IGP mask file you want to use. Spirent provides the file *iono grid points.txt* in the default location *… /IRNSS_data_sets/*<br>***Iono grid-point format*** (page 16-6) defines the format of the IRNSS grid-point file.<br>Click **…** to navigate to an "external" IGP mask file you want to use. The location of this file can be any folder on your C50r SimGEN Host or SimGEN Controller.<br>The text "Linked" shows SimGEN links the file shown to the scenario.<br>Click **Import** to navigate to an IGP mask file, as when clicking **…**<br>However, when you click **Open** in the dialog and select a file, SimGEN will import this file into the same folder as the file referencing it. This may be a scenario file (**.scn*) or the 'shared' folder; but, it is more likely to be a scenario source file, such as the signal sources file (**.irn*) here. SimGEN automatically updates the path to the file.<br>The text "Importing" shows SimGEN will import the IGP mask file you select, rather than referencing the file from its original location.<br>Notice SimGEN completes the import of the file when you click **OK** and save the new signal sources file to a name of your choice.<br>Subsequently, when you open this signal sources file, the IGP mask file you selected appears in the text area without a pathname, since it is present in the scenario folder.<br>The text "Linked" shows SimGEN links the file shown to the scenario. | | |

#### 16.6.1.1 Iono grid-point format

***Note****: If SimGEN cannot open or locate an iono grid point (IGP) mask file, it cannot broadcast Ionospheric correction messages and gives an error message*

The IRNSS ionospheric grid point mask (IGP Mask, MT5) defines the grid locations, which reference v) defines, that provide ionospheric correction information. Spirent supplies the text file *iono grid points.txt* (default location …*IRNSS_data_sets*\) that contains all the grid points in reference v).

You can prepare a new mask file, using a name of your choice, containing a subset of the grid points in reference v). Notice you cannot add grid points that reference v) does not define. If you use a mask file you generate, SimGEN will only use the grid points in this file and will disable the missing grid points.

The IRNSS navigation data message broadcasts GIVD, vertical ionospheric delay in metres; and GIVEI, the error index - see reference v). The relevant delay is also present in the RF signal at the output port of the signal generator.

The first two lines of *iono grid points.txt* include the IODI number at the top of the file, indicating the IODI to use. "!" at the start of a line indicates a comment.

Line three onwards specifies the grid-point parameters, using the format:

> Band_number (integer, 0 to 8) longitude (floating, degrees) latitude (floating, degrees);
> with a single space separating the parameters

You only need enter data you want to use; SimGEN sets missing data to "off".

Example partial listing of *ionogridpoints.txt*:

```
! Example file
IODI 1

0 60.0 0.0
0 65.0 0.0
0 70.0 0.0
0 75.0 0.0
0 80.0 0.0
0 85.0 0.0
```


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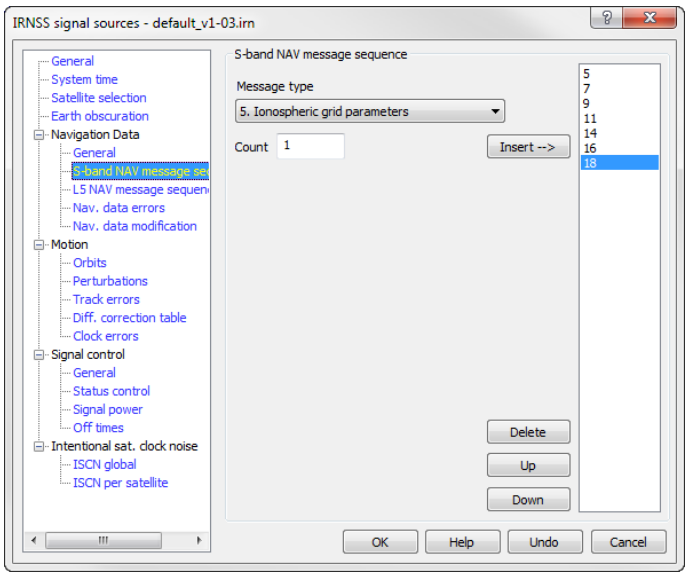
```
0 90.0 0.0
0 95.0  0.0
0 100.0  0.0
0 105.0  0.0

1 60.0 5.0
1 65.0 5.0
1 70.0 5.0
1 75.0 5.0
1 80.0 5.0
1 85.0 5.0
.
.
.
```

## 16.6.2 S-band NAV and L5 NAV message sequence

IRNSS S-band and L5 use the same dialog to enter S-band NAV and L5 NAV message sequences.

This figure shows the **S-band NAV message sequence** dialog:




The area on the right shows the message types in sequence of transmission, from top-to-bottom. By default, SimGEN enters one of each message type, in the order shown. You can select different **Message type**s to insert in the list and change the position in the list of any **Message type** shown, or **Delete** a message from the list.

| | | |
|---|---|---|
| **Message type** | Select from the message types (MT) shown in the table below.<br>You must not exceed the maximum broadcast interval shown. Notice that SimGEN does not issue a warning if you exceed the maximum broadcast interval.<br>Default: **5 - Ionospheric grid parameters** | |
| **Count** | Type the number of times you want to enter the **Message type**<br>Default: 1 | Range 1 to 100 |
| **Insert -->** | (default) Click to insert the **Message type** at the bottom of the list ;<br>or below the **Message type** you select in the list | |
| **Delete** | Click to delete the selected message type | |
| **Up**, **Down** | Click to move the selected message type up or down the list | |

| Message Type | Description | Maximum broadcast interval (at 50 symbols per second), minutes |
|---|---|---|
| 5 | Ionospheric grid parameters | 5 |
| 7 | Almanac parameters | 60 |


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| Message Type | Description | Maximum broadcast interval (at 50 symbols per second), minutes |
|---|---|---|
| 9 | UTC and Time Sync parameters wrt GPS | 20 |
| 11 | EOP and Ionospheric coefficients | 10 |
| 14 | Differential Corrections for one satellite | as needed |
| 16 | Encryption key subset | as needed |
| 18 | Text message | as needed |

## 16.6.3 Nav. data errors

***Notes**:*

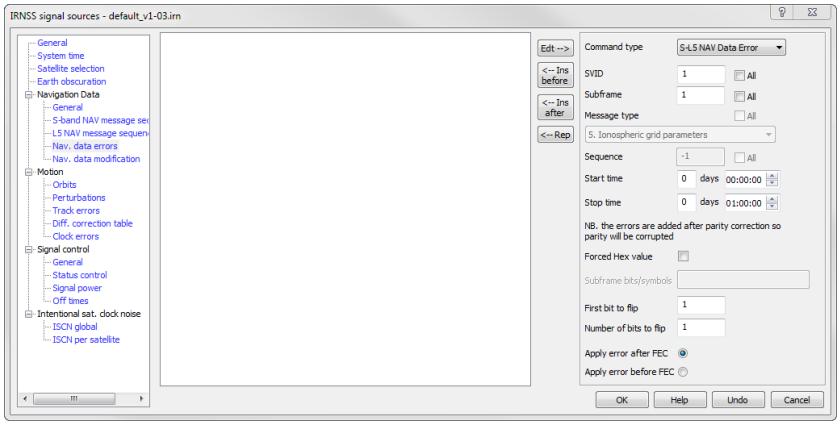
***1)** SimGEN calculates parity BEFORE making the changes, so SimGEN transmits data with incorrect parity. This tests the error detection and correction algorithms of your receiver. You can apply errors before or after FEC.*

***2)** To see the Help file topic on Navigation data errors for this constellation, Spirent recommend you select the Help topic from the **SimGEN Help-Contents** tab; clicking **Help** or pressing F1 on your keyboard may display an invalid Help topic.*

The following sections describe inserting IRNSS navigation data errors. Notice that you can enter commands that apply errors that are common to both S-band and L5 (using subframes 1 and 2) or that are specific to either S-band or L5 (using subframes 3 and 4).

### 16.6.3.1 S-L5 NAV Data Error

Use this command to insert IRNSS navigation data errors that are common to both S-band and L5. These errors will only take effect on subframe 1 or 2. This figure shows the dialog:




| | | | |
|---|---|---|---|
| **Command type** | Select **S-L5 NAV Data Error** | | |
| **SVID** | Type the SVID you want to use or select **All** | | |
| | | Range:1 to 16 | Default: 1 |
| **Subframe** | Type the subframe or select **All** | | |
| | | Range:1 to 2 | Default: 1 |
| **Start time**<br>**Stop time** | Units:<br>d hh:mm:ss | Range:<br>0 days 00:00:00<br>to 23 days 23:59:59 | **Start** default:<br>0 days 00:00:00 (start of run)<br>**Stop** default: 0 days 01:00:00 |

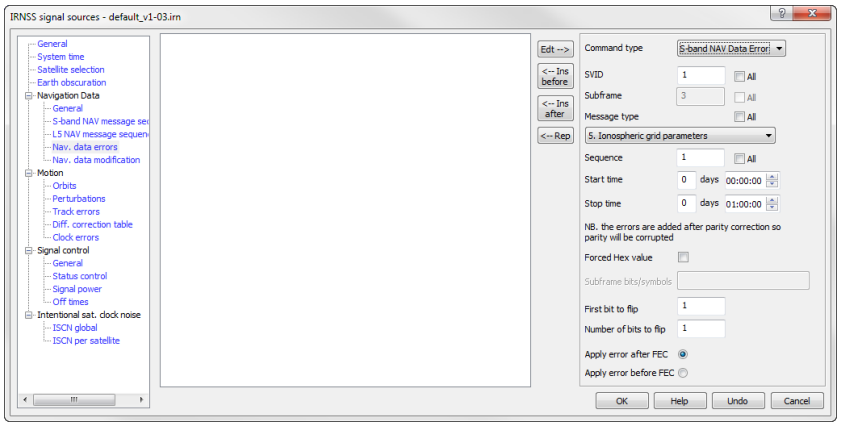

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| | |
|---|---|
| **Forced hex value** | Specify hexadecimal characters to use for the subframe message. The number of characters depends on when you apply FEC<br>deselected (default): enables **First bit to flip** and **Number of bits to flip**<br>disables **Subframe bits/symbols**<br>Select: enables **Subframe bits/symbols**<br>disables **First bit to flip** and **Number of bits to flip** |
| **Subframe bits/symbols** | The number of hexadecimal characters depends on:<br>**Apply error after FEC** selected, requires 150 hexadecimal characters<br>**Apply error before FEC** selected, requires 73 hexadecimal characters |
| ***Note**: To make up the required number of characters shown above, SimGEN adds to the broadcast navigation data message trailing zeroes to the number of characters you enter* | |
| **First bit to flip** | This depends on your choice of when to apply FEC:<br>Select **Apply error after FEC**: Type the first symbol of the 600 broadcast symbols to invert (flip)<br>Select **Apply error before FEC**: Type the first bit of the 292-bit message to invert (flip) |
| **Number of bits to flip** | Type the number of bits (or symbols) in the message to invert (flip) |
| **Apply error after FEC** | (default) Select to apply the error after SimGEN generates the symbol stream |
| **Apply error before FEC** | Select to apply the error before SimGEN generates the symbol stream - the CRC is invalid |
| ***Note**: SimGEN applies these errors after parity correction, so corrupting parity* | |

### 16.6.3.2 S-band and L5 NAV Data Error

Use these commands to enter navigation data errors that are specific to S-band or L5. These errors will appear on subframe 3 or subframe 4, depending on which subframe is available for broadcast. These errors will only affect the **Message type** you select.

This figure shows the **S-band NAV Data Error** dialog.



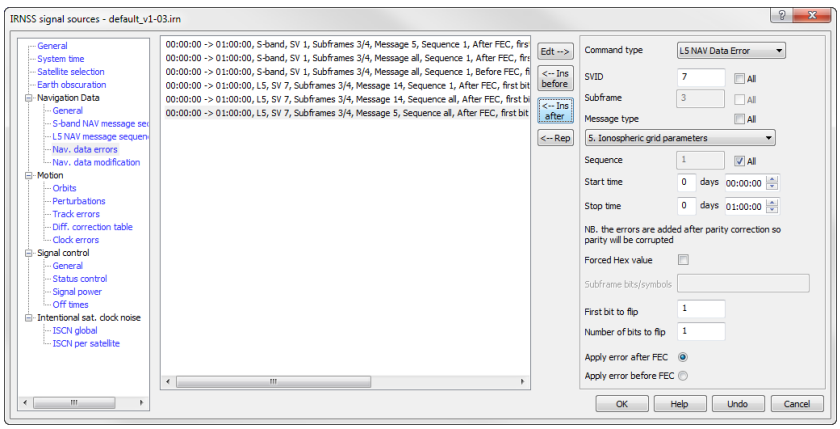

| | | | |
|---|---|---|---|
| **Command type** | Select from: **S-band NAV Data Error** or **L5 NAV Data Error** | | |
| **SVID** | Type the SVID you want to use or select **All** | | |
| | Range:1 to 16 | Default: 1 | |
| **Message type** | Select the message type from the drop-down shown in the table below or select **All** | | |
| **Sequence** | Type the sequence number or select **All**<br>**Message type** determines the **Sequence** Range and Default, see table below | | |
| **Start time**<br>**Stop time** | Units:<br>d hh:mm:ss | Range:<br>0 days 00:00:00<br>to 23 days 23:59:59 | **Start** default:<br>0 days 00:00:00 (start of run)<br>**Stop** default: 0 days 01:00:00 |


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| | |
|---|---|
| **Forced hex value** | Specify hexadecimal characters to use for the subframe message. The number of characters depends on when you apply FEC<br><br>(default) deselected: enables **First bit to flip** and **Number of bits to flip**<br>disables **Subframe bits/symbols**<br>Select: enables **Subframe bits/symbol**<br>disables **First bit to flip** and **Number of bits to flip** |
| **Subframe bits/symbols** | The number of hexadecimal characters depends on:<br>**Apply error after FEC** selected, requires 150 hexadecimal characters<br>**Apply error before FEC** selected, requires 73 hexadecimal characters |
| ***Note**: To make up the required number of characters shown above, SimGEN adds trailing zeroes to the number of characters you enter* | |
| **First bit to flip** | This depends on your choice of when to apply FEC:<br>Select **Apply error after FEC**: Type the first symbol of the 600 broadcast symbols to invert (flip)<br>Select **Apply error before FEC**: Type the first bit of the 292-bit message to invert (flip) |
| **Number of bits to flip** | Type the number of bits (or symbols) in the message to invert (flip) |
| **Apply error after FEC** | (default) Select to apply the error after SimGEN generates the symbol stream |
| **Apply error before FEC** | Select to apply the error before SimGEN generates the symbol stream - the CRC is invalid |
| ***Note**: SimGEN applies these errors after parity correction, so corrupting parity* | |

| Message type | Description | Range | Default |
|---|---|---|---|
| 5 | Ionospheric grid parameters | 1 to 6 | 6 |
| 7 | Almanac parameters | 1 to 16 | 16 |
| 9 | UTC and Time Sync Parameters wrt GNSS | not applicable | 1 |
| 11 | EOP and Ionospheric coefficients | not applicable | 1 |
| 14 | Differential Corrections for one satellite | 1 to 16 | 16 |
| 16 | Encryption key subset | not applicable | 1 |
| 18 | Text message | 1 to 256 | 256 |

The figure below shows example navigation data errors. The editor area on the right-hand side shows the parameters for the highlighted last line.





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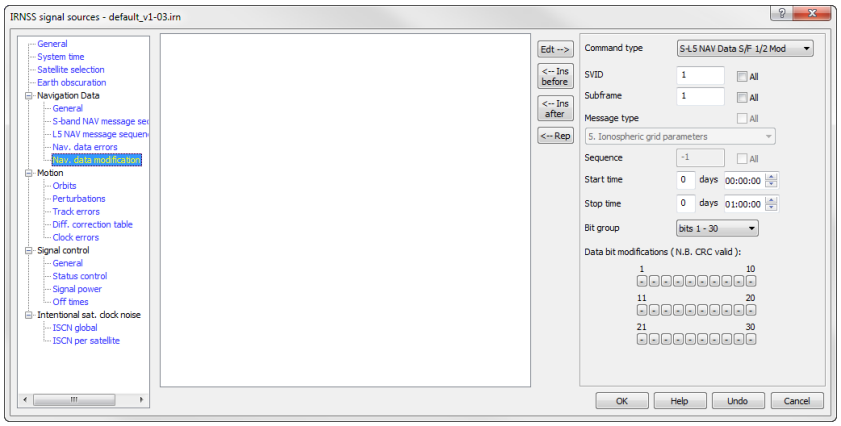
## 16.6.4 Nav. data modification

***Note**: To see the Help file topic on Navigation data modification for this constellation, Spirent recommend you select the Help topic from the **SimGEN Help-Contents** tab; clicking **Help** or pressing F1 on your keyboard may display an invalid Help topic.*

*S-L5 NAV Data S/F 1/2 Mod* (page 16-11) and *S-band and L5 NAV Data S/F 3/4 Mod* (page 16-11) describe modifying IRNSS navigation data.

### 16.6.4.1 S-L5 NAV Data S/F 1/2 Mod

Use this command to insert IRNSS navigation data modifications that are common to both S-band and L5 (S/F 1/2 in the command type meaning subframes 1 and 2). These modifications will only affect subframe 1 or subframe 2, depending on the subframe you select. This figure shows the dialog:



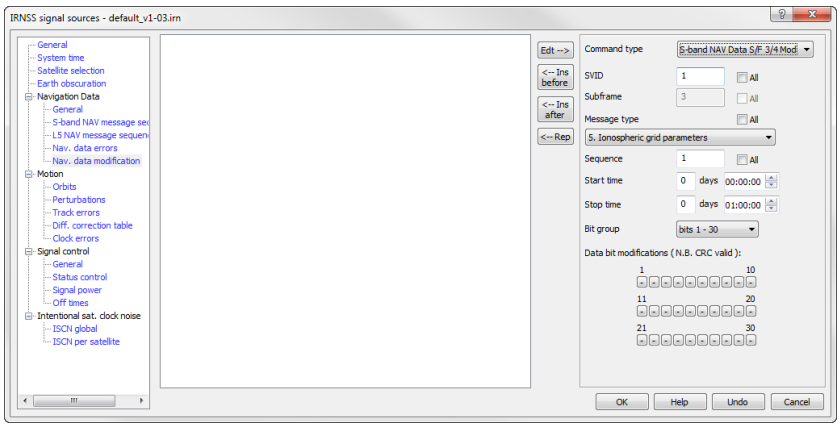

| | | | |
|---|---|---|---|
| **Command type** | Select: **S-L5 NAV Data S/F 1/2 Mod** | | |
| **SVID** | Type the SVID you want to use or select **All** | | |
| | Range: 1 to 16 | Default: 1 | |
| **Subframe** | Type the sequence number or select **All** | | |
| | | Range: 1 to 2 | Default: 1 |
| **Start time**<br>**Stop time** | Units:<br>d hh:mm:ss | Range:<br>0 days 00:00:00<br>to 23 days 23:59:59 | **Start** default:<br>0 days 00:00:00 (start of run)<br>**Stop** default: 0 days 01:00:00 |
| **Bit group** | Choose the group of 30 bits you want to modify from the drop-down list | | |
| **Data bit modification** | Modify each bit in the **Bit group** by clicking on the appropriate button. This table (page 10-16) details the symbols on each button.<br>The default is “leave bit as is”<br>These modifications maintain parity | | |

### 16.6.4.2 S-band and L5 NAV Data S/F 3/4 Mod

Use these commands to enter navigation data modifications that are specific to S-band or L5 (S/F 3/4 in the command type meaning subframes 3 and 4). These modifications will only affect subframe 3 or subframe 4, depending on the subframe available for broadcast. These modifications will only affect the **Message type** you select.

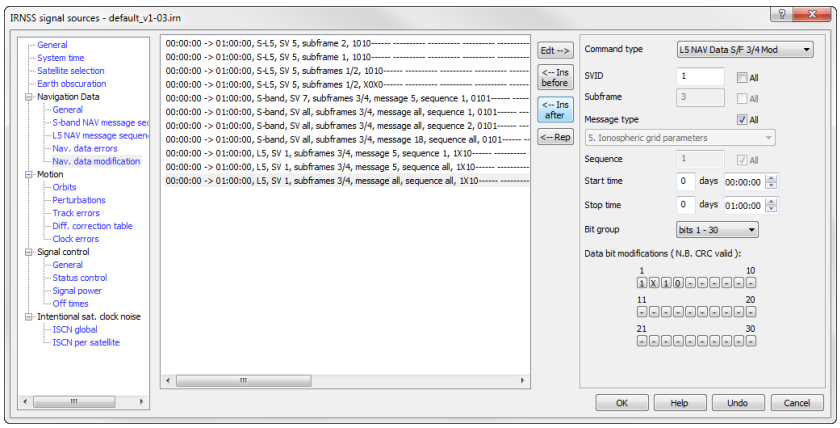
This figure shows the **S-band NAV Data S/F 3/4 Mod** dialog.


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| | | | |
|---|---|---|---|
| **Command type** | Select from: **S-band NAV Data S/F 3/4 Mod** or **L5 NAV Data S/F 3/4 Mod** | | |
| **SVID** | Type the **SVID** you want to use or select **All** | | |
| | | Range:1 to 16 | Default: 1 |
| **Message type** | Select the message type from the drop-down shown in the figure below or select All | | |
| **Sequence** | Type the sequence number or select **All**<br>Message type determines the **Sequence Range** and **Default**, see this table (page 16-10) | | |
| **Start time**<br>**Stop time** | Units:<br>d hh:mm:ss | Range:<br>0 days 00:00:00<br>to 23 days 23:59:59 | Start default:<br>0 days 00:00:00 (start of run)<br>Stop default: 0 days 01:00:00 |
| **Bit group** | Choose the group of 30 bits you want to modify from the drop-down list | | |
| **Data bit modification** | Modify each bit in the **Bit group** by clicking on the appropriate button. This table (page 10-16) details the symbols on each button.<br>The default is “leave bit as is”<br>These modifications maintain parity | | |

The figure below shows example navigation data modifications. The editor area on the right-hand side shows the parameters for the highlighted last line.




## 16.7 Motion

SimGEN has the capability to simulate up to sixteen IRNSS satellites. With four geostationary satellites, twelve geosynchronous satellites are available for the two orbital planes.

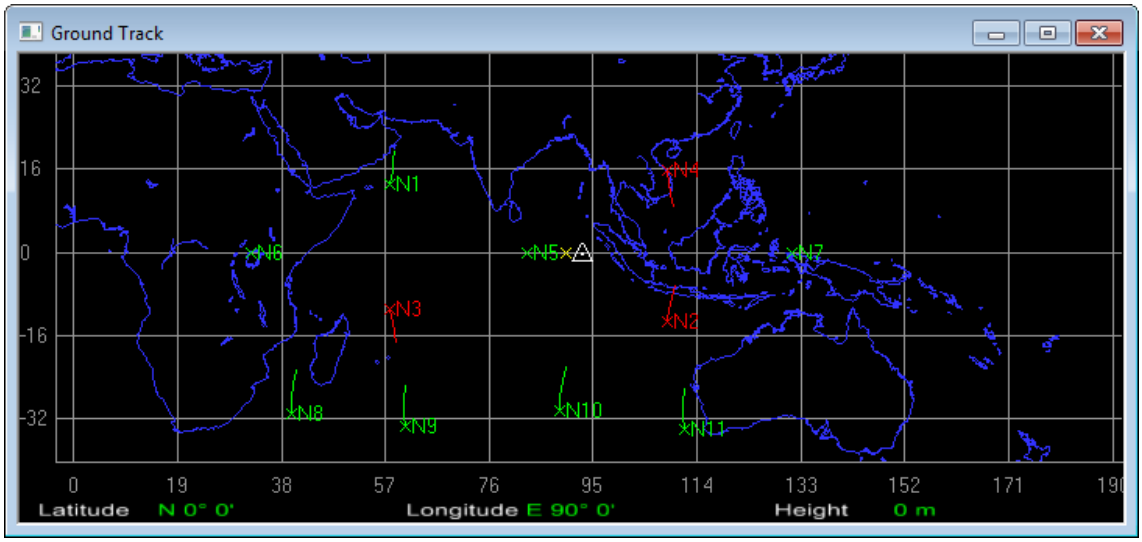
Currently, SimGEN sets the first seven satellites as present in the scenario and selected by default in ***Motion - Orbits*-Present** (page 16-13), with satellites 5, 6, 7 (and 16) geostationary.
All other satellites are geosynchronous, with an inclination of 29° and eccentricity of 0.002, in two orbital planes:

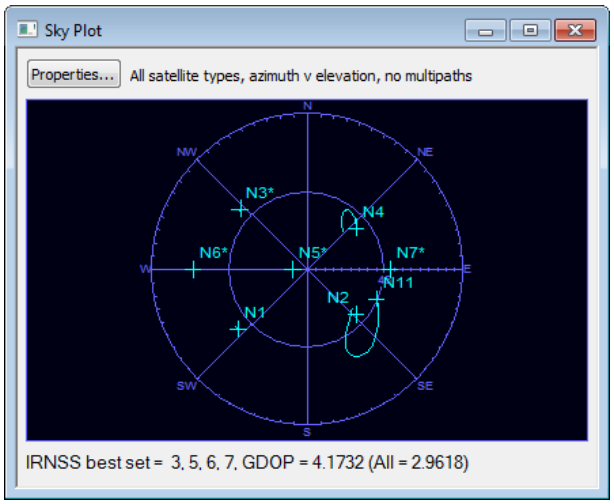
→ One plane crossing the equator at a longitude of 55° East


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→ The other plane crossing the equator at a longitude of 111.75° East.

The two figures below show the SimGEN **Ground Track** and **Sky Plot** windows after running an IRNSS scenario using a static vehicle. Satellites N5, N6 and N7 are geostationary, with satellites N1 to N4 geosynchronous.




Reference a) defines the GPS terms in the dialogs and reference v) defines the IRNSS specific terms.

## 16.7.1 Motion - Orbits

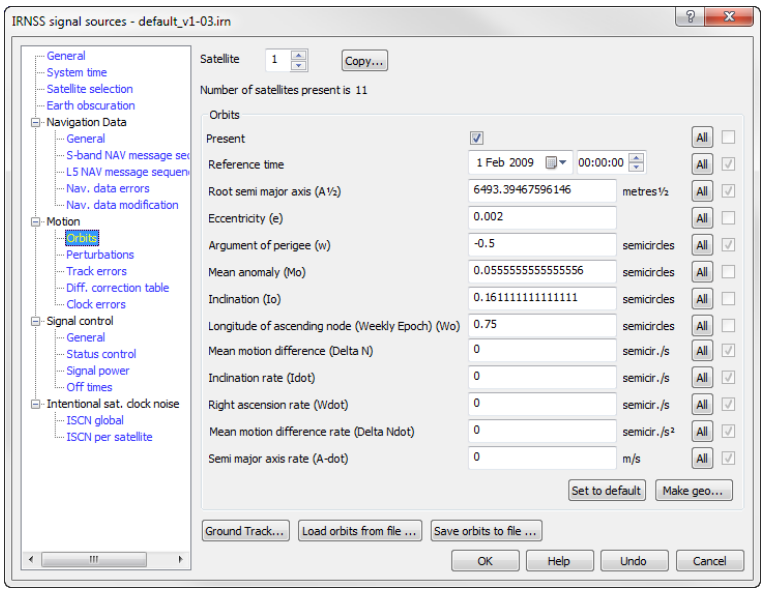
***Note**: Spirent recommends you change default values with care. Unlike GPS satellites, a significant change in some parameters may move a satellite out of the IRNSS service region and effectively invalidate that satellite.*

This dialog is the same as the **GPS-*Motion - Orbits*** (page 10-21), although parameter values may not be the same.

Use this dialog to specify orbital parameters for each IRNSS satellite.

The default values give satellite orbits that are appropriate for the IRNSS service region. The figure below (and the corresponding details in the parameter listing below the figure) shows the default values for the geosynchronous **Satellite 4**.


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The dialog shows the parameters for the **Satellite**. As you scroll through the satellites, using the arrow buttons on the right-hand side of the **Satellite** number, the orbital parameters alter accordingly. The dialog shows the **Number of satellites** present in the scenario.

| | | | |
|---|---|---|---|
| **Satellite** | Enter the satellite number whose details you want to modify. This table shows defaults for **Satellite 4** | | |
| **Present** | Select (default): includes **Satellite** in the scenario<br>Deselect: treats **Satellite** as non-existent and does not include it in the Navigation data almanac set. | | |
| **Reference time** | This time is analogous to toe in the GPS satellite data message. | | |
| | Units: d hh:mm:ss.ss | Range: 06 January 1980 00:00:00.00 to 23 January 2100 00:00:00.00 | |
| **Root semi major axis ($A^{½}$)** | Units: $metres^{½}$ | Range: 2 537.0 to 6 557.0 $m^{½}$ | Default: 6493.394 675 961 46 |
| **Eccentricity (e)** | Units: none | Range: 0 to 0.03125 | Default: 0.002 (zero for geo-stationary satellites) |
| **Argument of perigee (w)** | Units: semi-circles | Range: -1 to +1 semi-circle | Default: -0.5 |
| **Mean anomaly (Mo)** | Units: semi-circles | Range: -1 to +1 semi-circle | Default: -0.601 388 888 888 889 (varies with **Satellite**) |
| **Inclination (Io)** | Units: semi-circles | Range: -1 to +1 semi-circle | Default: 0.161 111 111 111 111 (zero for geo-stationary satellites) |
| **Longitude of ascending node (Weekly Epoch) (Wo)** | Units: semi-circles | Range: -1 to +1 semi-circle | Default: -0.277 777 777 777 778 (varies with **Satellite**) |
| ***Note**: The reference time for **Wo** is the weekly epoch at or before the orbit reference time* | | | |
| **Mean motion difference (Delta N)** | Units: semi-circles per second | Range: -3.725 29 E-9 to +3.725 177 E-9 $semicircles.s^{-1}$ | Default: 0 |
| **Inclination rate (Idot)** | Units: semi-circles per second | Range: -9.313 227 8 E-10 to +9.312 088 9 E-10 $semicircles.s^{-1}$ | Default: 0 |


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| | | | |
|---|---|---|---|
| ***Note**: When there is a large difference between **Reference Time** and the start of the scenario, use **Inclination rate** with caution. Extrapolation of the ephemeris over a long period could cause a significant change in inclination angle, so the resulting orbit is not typical of an IRNSS satellite.* | | | |
| **Right ascension rate (Wdot)** | Units: semi-circles per second | Range: -1.192 092 89 E-7 to +1.192 056 5 E-7 semicircles.s$^{-1}$ | Default: 0 |
| ***Note**: When there is a large difference between **Reference Time** and the start of the scenario use **Right ascension rate** with caution. Extrapolation of the ephemeris over a long period could cause a significant change in **Longitude of ascending node** so the resulting orbit is not typical of an IRNSS satellite.* | | | |
| **Mean motion difference rate (Delta Ndot)** | Units: semi-circles per (second)$^2$ | Range: ±2.273 736 754 43 E-13 semicircles.s$^{-2}$ | Default: 0 |
| **Semi major axis rate (A-dot)** | Units: metres per second | Range: -8.0 to +7.999 999 952 m.s$^{-1}$ | Default: 0 |

#### 16.7.1.1 Buttons

***Note**: Currently, Spirent is not aware of a download site for TLE format files for the IRNSS constellation. However, this link: http://www.n2yo.com/database/?q=irnss provides IRNSS satellite data. Click on the IRNSS satellite you want to use and that page includes TLE format data.*

*(To use this file in SimGEN, you must change its extension to *.tle)*

The buttons in the **Motion-Orbits** dialog are identical to those for GPS satellites see **GPS-*Motion - Orbits*** (page 10-21).

### 16.7.2 Motion - Perturbations

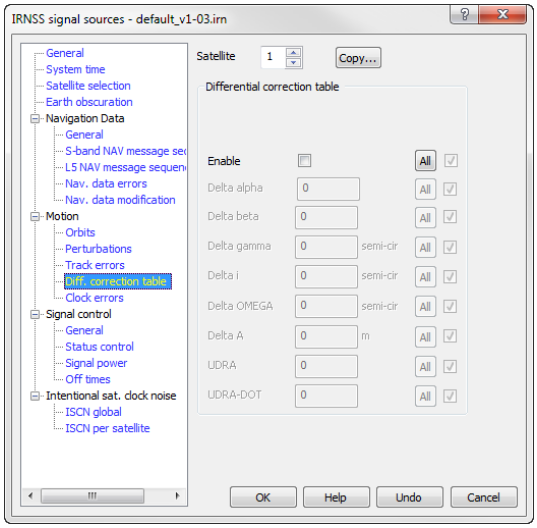
The dialog is the same as **GPS-*Motion - Perturbations*** (page 10-34), except for the range of Cuc, Cus, Cic and Cis: -61.03516 to +61.03143 microradians.

### 16.7.3 Motion - Track Errors

The dialog is the same as **GPS-*Motion - Track errors*** (page 10-35).

### 16.7.4 Motion - Diff. correction table

The dialog is based on **GPS-*Motion - Differential correction table*** (page 10-35) (with a slightly different dialog, see the figure below) although parameter values may not be the same.




### 16.7.5 Motion - Clock errors

***Note**: Setting the **Delta Af0** clock divergence term is the same as applying a pseudorange error to that satellite.*

This dialog is the same as **GPS-*Motion - Clock errors*** (page 10-37), although parameter values may not be the same.

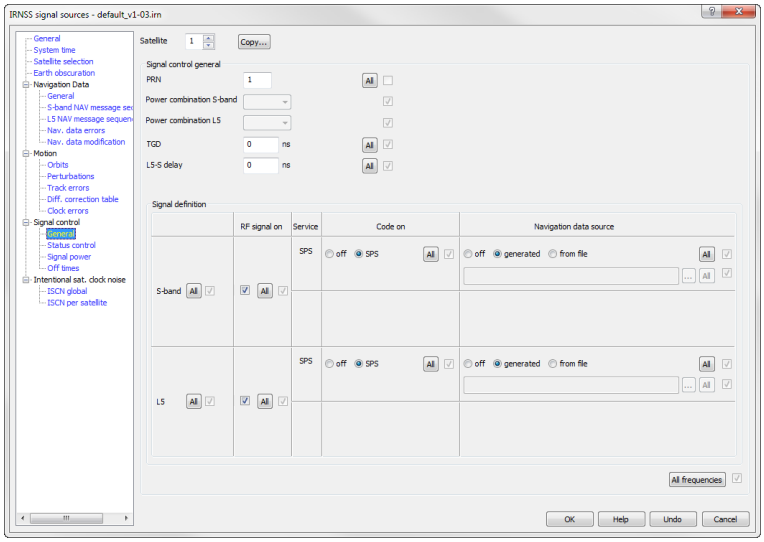

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# 16.8 Signal control

Use the dialogs in the following sections to enter signal parameters for each IRNSS satellite.

## 16.8.1 Signal control - General

Use this dialog to specify characteristics of the IRNSS signal:




| | | | |
|---|---|---|---|
| **Satellite** | Select the IRNSS Satellite whose settings you want to change. | | |
| **Signal control general** | | | |
| **PRN** | Set the **PRN** of Satellite | Range: 1 to 16 | |
| **TGD** | Set the Group Delay of the Satellite signals<br>Click **All** to use the same value of TGD for all Satellites | | |
| | Units: nanosecond | Range: -59.605 to +59.139 ns | Default: 0 |
| **S-band and L5** | Set the **Code** and **Navigation data source** for S-band and L5 frequencies | | |
| **Code on** | Select (default): ranging code on<br>Deselect: ranging code off<br>**All** (satellites) selected by default | | |
| **Navigation data source** | Choose from:<br>**off** (default) (navigation data not broadcast)<br>**generated**: by SimGEN<br>**from file**: click ... and select the navigation data file.<br>The default location of these files is the folder IRNSS data sets.<br>The S-band navigation data file uses the extension **.s-band_nav*<br>The L5 navigation data file uses the extension **.l5_nav*<br><br>***Navigation data source file formats*** gives details of these file formats.<br><br>Click **All** to use the same navigation data source (**off**/**generated**/**from file**) for all **Satellites**<br>SimGEN selects **All** (next to filename browse button) by default (so that all satellites use the same S-band navigation data file and the same L5 navigation data file) | | |

### 16.8.1.1 Navigation data source file formats

***Note**: To prevent early termination of your run, you must ensure the content of the navigation data file will generate the satellite signal for the length of your simulation.*

SimGEN can read IRNSS S-band and L5 navigation data from a user-defined file.


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Details of the navigation file:

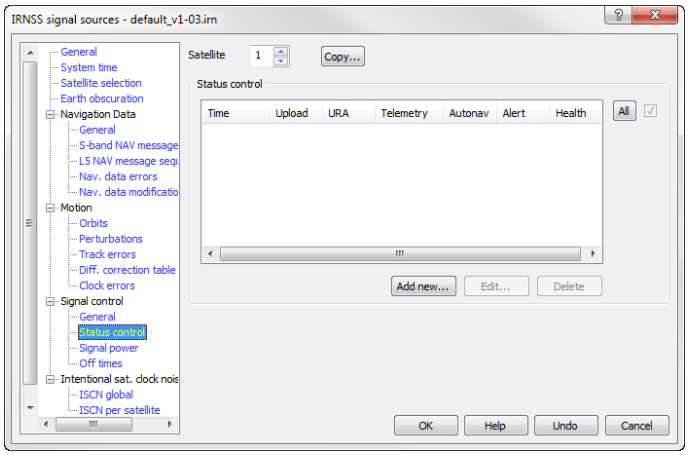
- The first line of the file must be the start time of the scenario (or time of applicability) and must use this format: DD-MMM-YYYY HH:MM:SS.
- You must identify comments using '!' at the start of the commented line.
- Navigation data must consist of 600 symbols (150 hexadecimal characters) per sub-frame, per line.
- The 600 symbols take 12 seconds to transmit (50 symbols per second) and represent the navigation data stream after passing through the FEC encoder and interleaving.

For example:

```
05-Jul-2009 20:10:00
! Complete nav data messages each containing 600 symbols, or 150 hex chars
111110123456789012345678901234567890123456789012345678901234567890……1234567890123456789
211110123456789012345678901234567890123456789012345678901234567890……1234567890123456789
```

## 16.8.2 Signal control - Status control

Use this dialog to edit or create status control data. This figure shows the default settings:



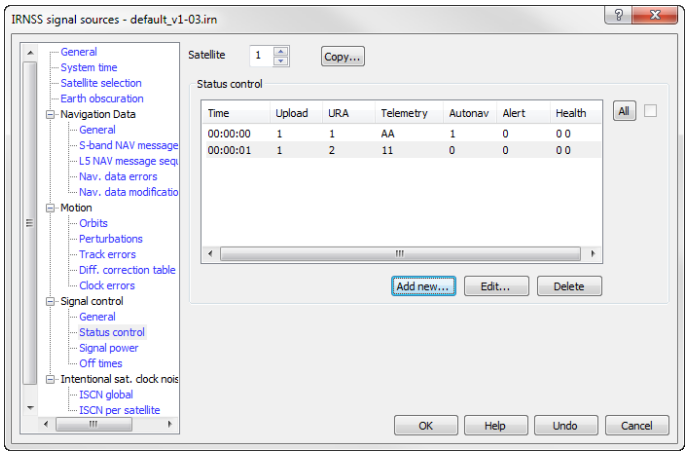

Click **All** to set the status control of all satellites to that of the current satellite.

To add a new status control line see ***Add a new status control***, then click **Add new…**

To edit an existing line in the status control area, highlight the line and click **Edit…**

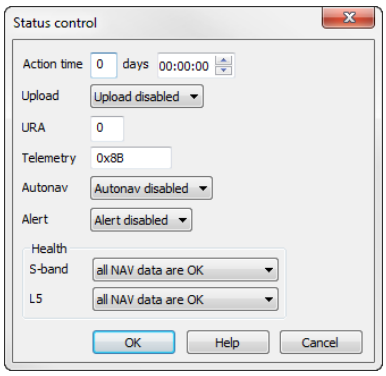
To delete an existing line in the status control area, highlight the line and click **Delete**

This figure shows some status controls:




### 16.8.2.1 Add a new status control

Clicking **Status Control-Add new…** opens this dialog:

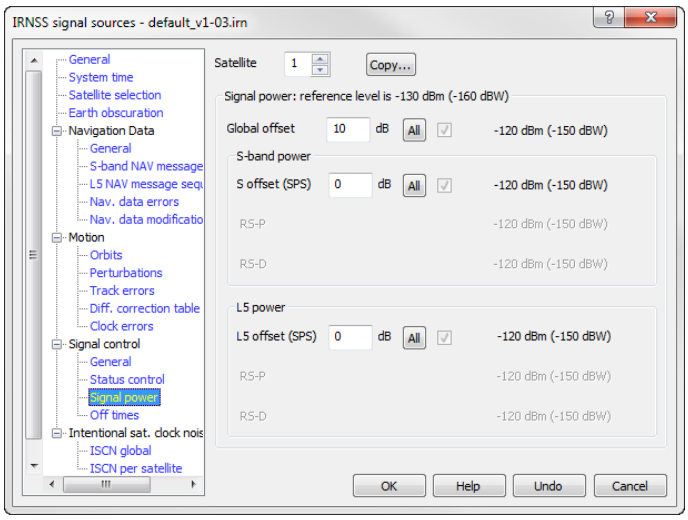



| | | | |
|---|---|---|---|
| **Action time** | The time into the scenario you want to send the new status | | |
| | Units:<br>d hh:mm:ss | Range:<br>0 days 00:00:00<br>to 23 days 23:59:59 | Default:<br>0 days 00:00:00 |
| **Upload** | Uploads almanac and / or ephemeris data at the next, or current, Frame epoch. | | |
| | Choose from:<br>**Upload disabled** (default)<br>**Upload enabled** | | |
| **URA** | Type the new value of URA you want to use | | |
| | Units: none | Range: 0 to 15 | Default: 0 |
| **Telemetry** | Currently undefined.<br>Spirent provides two hexadecimal characters to set the 8-bit TLM message to any value - see reference v). | | |
| | Units: none | Range:0x00 to 0xFF | Default: 0x8B |
| **Autonav** | The autonav flag indicates the satellite is using ephemeris and clock set data that is more than one day old<br>Choose from:<br>**Autonav disabled** (default)<br>**Autonav enabled** | | |
| **Alert** | IRNSS uses the Alert flag to indicate satellite manoeuvre, satellite thruster activity, satellite is in “safe” mode or on anomalous clock behaviour<br>Choose from:<br>**Alert disabled** (default)<br>**Alert enabled** | | |
| **Health** | Set the health status of the S-band and L5 navigation data | | |
| **S-band**, **L5** | Choose from:<br>**all NAV data are OK** (default)<br>**some or all NAV data are bad** | | |

### 16.8.3 Signal control - Signal power

Use this dialog to control the signal level characteristics of all simulated carrier frequencies at the RF output of the RF Upconverter:


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If you select <**scenario name**>**-signal sources file-*General*-Signal Strength-Modelled**, SimGEN applies the values you enter in this dialog before performing modelling.

| | | | |
|---|---|---|---|
| **Satellite** | Select the **Satellite** whose settings you want to change | | |
| **Signal power** | ***Note**: For all signals, the power level SimGEN applies is shown to the right of **All***<br><br>Set the signal power offsets from the IRNSS reference level of -130 dBm for both **S-band power** and **L5 power** | | |
| **Global offset** | Type the Global offset (of both S-band and L5 powers) with respect to the reference level | | |
| | Units: decibels | Range: -20.0 to +20.0 dB | Default: 10 |
| **S-band power-S offset** and **L5 power-L5 offset** | Type the relative power offset for **S-band power** and **L5 power** | | |
| | Units: decibels | Range: -20.0 to +20.0 dB | Default:<br>0 (S-band)<br>0 (L5) |

Click **All** to apply that power level offset to all IRNSS satellites.

## 16.9 Signal control - Off times

This dialog is the same as **GPS-*Signal Control - Off times*** (page 10-50).

## 16.10 SPS PRN codes

***Notes**:*

***1)** The signal generator does not permanently store these PRN codes. They are lost when you turn off ac power to the signal generator*

***2)** Spirent does not supply example PRN files.*

***3)** Reference v) details the format of the PRN file. You must save the PRN file with the filename, and in the location, this section defines.*

To assign a PRN to a satellite, open ***Signal control - General*** and type the PRN for the satellite in **PRN**. You can assign one PRN to be used for all satellites (by clicking **All**), or you can assign a different PRN for each satellite (by typing the PRN for each satellite SVID).

### 16.10.1 Filename and location

This table details the SPS PRN filenames. You must use using the filename format as shown.


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| SPS PRN file | Filename |
|---|---|
| L5 | *irnss_prns_L5_SPS.dat* |
| S-band | *irnss_prns_S_SPS.dat* |

Save these files in the folder (which you must first create):
*D:\posapp\software\<version>\gui \IRNSS_data_sets*

(for GSS8000-series and earlier signal generators: *C:\Program Files\Spirent Communications\Positioning Application\IRNSS_data_sets)*

## 16.11 Intentional satellite clock noise

This is the same as **GPS-*Intentional sat clock noise*** (page 10-51)



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# 17 CAPS constellation editor

***Licenced feature**: You will need a licence to use this feature. Contact Spirent for licencing details.*

***Note**: Currently, Spirent supports the CAPS constellation as part of a Tailored Solution (Spirent's term for specialist, non-COTS, products and / or applications). Contact Spirent Global Services for further details*

The Chinese Area Positioning System (CAPS) constellation offers a service that will extend across China and cover a large area of South-East Asia and Australia. The CAPS constellation consists of seven satellites. Unlike other satellite navigation systems, ground stations transmit the navigation data messages to each satellite, which then re-transmits the message, so each satellite acts purely as a transponder. CAPS uses C-band frequencies for the downlink to CAPS receivers and for the uplink from ground stations to the satellites. Currently Spirent does not model uplink transmissions from ground station to satellite.

Since CAPS satellites are geostationary and geosynchronous in space, they cannot provide good 3D positioning. Therefore, CAPS receivers incorporate a barometer to provide a height estimate. To help calibrate the barometer, CAPS ground stations collect pressure and temperature data from weather stations around China and broadcast this information as part of the navigation message. The positioning principle is the same as GPS, except for barometric estimation of height to provide a three-dimensional fix.

CAPS satellites do not carry atomic clocks and rely a master clock located at the ground station. The navigation message can broadcast the time offset between master clocks.

The CAPS signal structure has coarse acquisition and precise codes, similar to that of GPS. This table gives the CAPS constellation signals, frequencies and reference levels.

| Signal | Carrier centre frequency, MHz | Power reference level, dBm |
|---|---|---|
| C1 | 4 143.15 | -138 |
| C2 | 3 979.47 | -138 |
| C3 | 3 826.02 | -138 |

Reference x) gives the CAPS ICD.

PosApp version 4.02 onwards supports CAPS for GSS8000-series signal generators when using signal generator card firmware version 2-26(or later) and FPGA image release 25 (or later).

To find the firmware version and FPGA image of your signal generator cards and then determine if your signal generator needs upgrading, Spirent recommends you follow this procedure:

- → Read the section on the menu item **Options-*Hardware Configuration*** (page 5-18), then display your signal generator configuration
- → Select your signal generator
- → Click **Output details…**
- → Contact Spirent Global Services and provide the relevant details from the configuration window.
- → Spirent Global Services will then determine if your signal generator needs upgrading and provide details on the upgrade procedure.

The CAPS constellation editor is similar to the ***GPS constellation editor*** (page 10-1). If this Chapter on the CAPS constellation editor does not give details for a scenario parameter, see the details for the parameter with the same name in the ***GPS constellation editor***.

The **CAPS constellation-Signal sources file** characterises the CAPS satellites in a simulation. This file is often known as the "CAPS Constellation file", and is one of the source files defining a scenario. The default signal sources filename for the CAPS constellation is *default_vx-yy.cap*, where *x-yy* is the version number.

To use the CAPS constellation, first see **Receive and transmit antennas-*Associate a GNSS signal with an antenna*** (page 23-4) and associate the CAPS signal with the antenna(s) you want to use.


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The upconversion process Spirent uses to generate the CAPS signal imposes a limitation on the Doppler velocity of the vehicle. This limitation is also dependant on the Simulation iteration rate, set in ***General Options*** **-Simulation iteration rate** (page 4-15), and the CAPS signal you choose, see the following table:

***Note**: If you first use 100 milliseconds Simulation Iteration Rate in a scenario and then change to using 10 milliseconds or 4 milliseconds, ensure you do not exceed the maximum Doppler velocities shown in the table below*

| Simulation iteration rate, milliseconds | Maximum Doppler velocity for C1, $m.s^{-1}$ | Maximum Doppler velocity for C2, $m.s^{-1}$ | Maximum Doppler velocity for C3, $m.s^{-1}$ |
|---|---|---|---|
| 4 | ±47 420 | ±49 371 | ±51 351 |
| 10 | ±47 420 | ±49 371 | ±51 351 |
| 100 | ±94 841 | ±98 742 | ±102 703 |

## 17.1 CAPS constellation editor

***Note**: The range of parameter values you can enter in PosApp may be different from the values commonly used in satellite navigation systems.*

Use the constellation editor to edit data in the CAPS constellation file. The editor shows the data in the CAPS constellation file as a series of “pages”. The left-hand area shows the pages you can select for editing; the right-hand area shows the details of the page you selected in the left-hand area. This section describes how you select and change details in the right-hand area.

SimGEN checks the range of the value you type in a text box and, if incorrect, displays the range of acceptable values.

After associating the CAPS signal type with an antenna, the CAPS constellation file appears in the **Scenario contents** window:



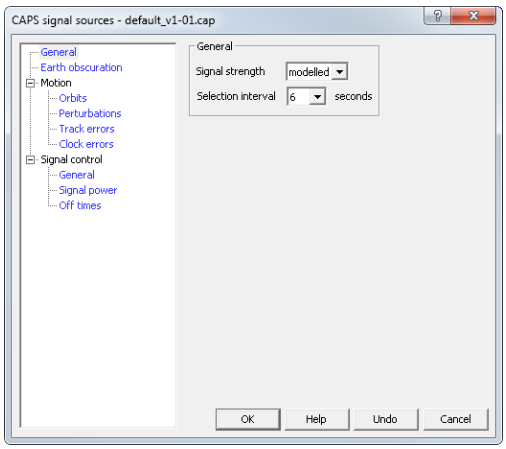

**Receive and transmit antennas-*Transmitter antenna level and phase*** patterns (page 23-20) details creating and applying **Tx antenna patterns**.

Edit the CAPS constellation file in the same way as you would edit a GPS constellation file. First, expand **CAPS constellation**. Then:

→ Select **CAPS constellation-Signal sources file**

→ Right-click and select **Edit**

→ You will see the **Signal sources-General** dialog, shown below. The CAPS signal sources file has the default name, *default_vx-yy.cap*.





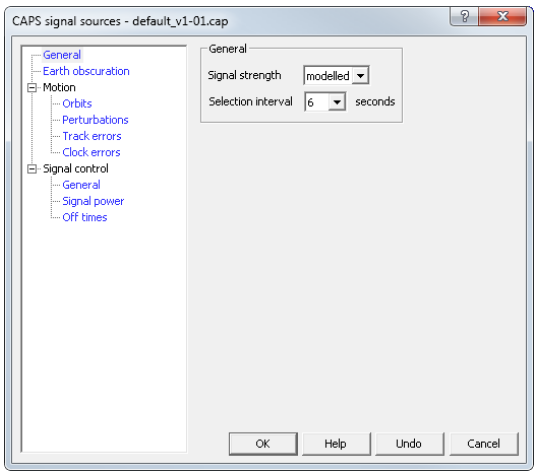
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→ The left-hand area of the **Signal sources** dialog shows the titles of all “pages” you can edit in the file. Click on a title to edit it.

After editing the **Signal sources file** click **OK**, then save the file to a name of your choice using the dialog. Select **Shared** to save this file to the shared folder, so making it available to other scenarios.

## 17.2 General

Use the **General** dialog, see below, to edit the parameters affecting all CAPS satellites.




| | | | |
|---|---|---|---|
| **Signal strength** | Select whether SimGEN modifies satellite signal-levels based on satellite-to-antenna distance or uses a fixed signal level. **GPS-*General - Modelled and fixed signal strength*** (page 10-8) gives further details on Modelled and Fixed. In each case, first set the base RF power level using ***Signal control - Signal power*** (page 17-8) | | |
| | Choose from: | | |
| **Modelled** | (default) SimGEN modifies satellite signal level as a function of the satellite to receiver antenna distance in proportion to 1/(distance)$^2$ | | |
| **Fixed** | SimGEN does not modify the signal level as a function of satellite to receiver antenna distance. | | |
| **Selection interval** | The interval, during which, SimGEN revises the simulated set of satellites. In general, SimGEN simulates all visible satellites so this set will only change when a satellite rises or sets (disappears from view, with ***Earth obscuration*** (page 10-11) defining the visibility criteria).<br>Spirent recommends you use the default interval, except where the content of satellite signals is constantly changing (for example, due to your vehicle’s motion in conjunction with a receiver antenna pattern that is highly directional), when Spirent recommends reducing the **Sampling interval**.<br>However, as it takes SimGEN up to one second to start a new satellite on a signal generator channel, if SimGEN includes satellites in the simulated set for very brief periods (a few seconds) there is a significant reduction in the satellite’s active simulation time. | | |
| | Units: seconds | Range: 1 to 600 s | Default: 6 |
| **UTC offset at scenario start** | Offset between IRNASS system time and UTC | | |
| **A0: offset** | Units: microseconds | Range: -100 to +100 µs | Default: 0 |
| **A1: offset rate** | Units: microseconds per second | Range: -0.007 4 to +0.007 4 µs.s$^{-1}$ | Default: 0 |
| **A2: offset acceleration** | Units: microseconds per (second)$^2$ | Range: -2.17 E -13 to +2.13 E -13 µs.s$^{-2}$ | Default: 0 |


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## 17.3 Earth obscuration

This dialog is the same as the **GPS-*Earth obscuration*** (page 10-11).

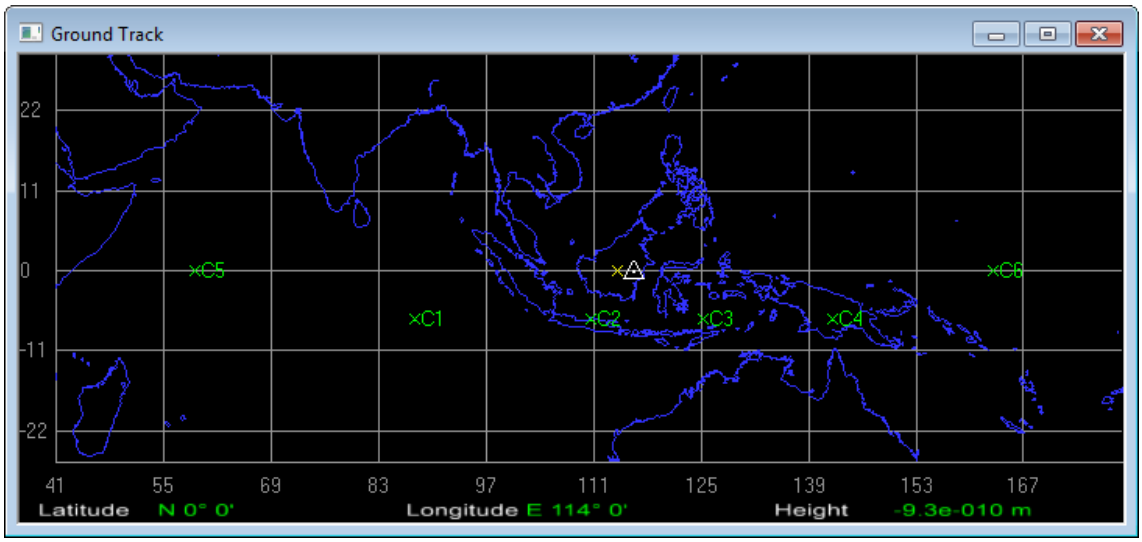
## 17.4 Motion

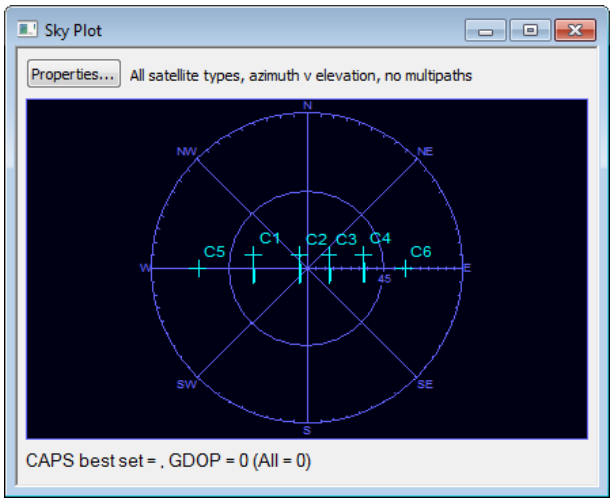
Currently, SimGEN sets the first six satellites as present in the scenario (selected, by default, in ***Motion - Orbits*-Present**). These are arranged as follows:

Satellites 1 to 4 are geosynchronous and will perform “figure-of-eight” orbits, centred at longitudes 87.5 ºEast, 110.5 ºEast, 125 ºEast, and 142 ºEast.

Satellites 5 and 6 are geostationary, at 59°East and 163°East.

The two figures below show the SimGEN **Ground Track** and **Sky Plot** windows after running a CAPS scenario using a static vehicle. Satellites C5 and C6 are geostationary, with satellites C1 to C4 geosynchronous.




The following sections describe how SimGEN models CAPS satellite motion.

Reference a) defines the GPS terms in the dialogs and reference x) defines the CAPS specific terms.

### 17.4.1 Motion - Orbits

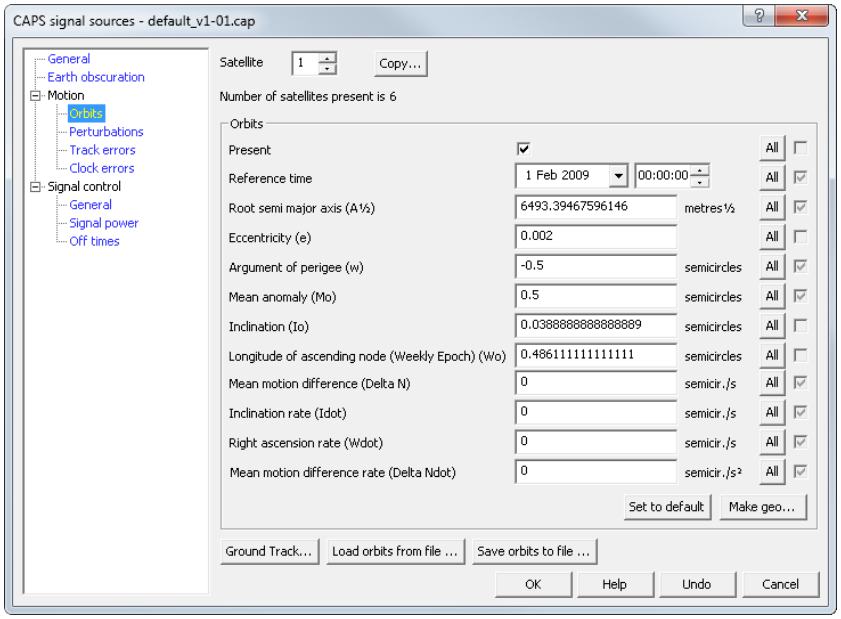
***Note**: Spirent recommends you change default values with care. Unlike GPS satellites, a significant change in some parameters may move a satellite out of the CAPS service region and effectively invalidate that satellite.*

This dialog is the same as the **GPS-*Motion - Orbits*** (page 10-21), although parameter values may not be the same.

Use this dialog to specify orbital parameters for each CAPS satellite.


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The default values give satellite orbits that are appropriate for the CAPS service region. The figure below (and the corresponding details in the parameter listing below the figure) shows the default values for the geosynchronous **Satellite 1**.




The dialog shows the parameters for the **Satellite**. As you scroll through the satellites, using the arrow buttons on the right-hand side of the **Satellite** number, the orbital parameters alter accordingly. The dialog shows the **Number of satellites** present in the scenario.

| | | | |
|---|---|---|---|
| **Satellite** | Enter the satellite number whose details you want to modify. This table shows defaults for **Satellite 1** | | |
| **Present** | Select (default): includes **Satellite** in the scenario<br>Deselect: treats **Satellite** as non-existent and does not include it in the Navigation data almanac set. | | |
| **Reference time** | This time is analogous to toe in the GPS satellite data message. | | |
| | Units: d hh:mm:ss.ss | Range: 06 January 1980 00:00:00.00 to 23 January 2100 00:00:00.00 | |
| **Root semi major axis ($A^{½}$)** | Units: $metres^{½}$ | Range: 2 537.0 to 6 557.0 $m^{½}$ | Default: 6493.394 675 961 46 |
| **Eccentricity (e)** | Units: none | Range: 0 to 0.03125 | Default: 0.002 (zero for geo-stationary satellites) |
| **Argument of perigee (w)** | Units: semi-circles | Range: -1 to +1 semi-circle | Default: -0.5 |
| **Mean anomaly (Mo)** | Units: semi-circles | Range: -1 to +1 semi-circle | Default: 0.5 (varies with **Satellite**) |
| **Inclination (Io)** | Units: semi-circles | Range: -1 to +1 semi-circle | Default: 0.038 888 888 888 888 9 (zero for geo-stationary satellites) |
| **Longitude of ascending node (Weekly Epoch) (Wo)** | Units: semi-circles | Range: -1 to +1 semi-circle | Default: 0.486 111 111 111 111 (varies with **Satellite**) |
| ***Note**: The reference time for **Wo** is the weekly epoch at or before the orbit reference time* | | | |

| | | | |
|---|---|---|---|
| **Mean motion difference (Delta N)** | Units: semi-circles per second | Range: -3.725 29 E-9 to +3.725 177 E-9 semicircles.s$^{-1}$ | Default: 0 |
| **Inclination rate (Idot)** | Units: semi-circles per second | Range: -9.313 227 8 E-10 to +9.312 088 9 E-10 semicircles.s$^{-1}$ | Default: 0 |
| ***Note**: When there is a large difference between **Reference Time** and the start of the scenario, use **Inclination rate** with caution. Extrapolation of the ephemeris over a long period could cause a significant change in inclination angle, so the resulting orbit is not typical of a CAPS satellite.* | | | |
| **Right ascension rate (Wdot)** | Units: semi-circles per second | Range: -9.536 742 8 E-7 to +9.536 742 E-7 semicircles.s$^{-1}$ | Default: 0 |
| ***Note**: When there is a large difference between **Reference Time** and the start of the scenario use **Right ascension rate** with caution. Extrapolation of the ephemeris over a long period could cause a significant change in **Longitude of ascending node** so the resulting orbit is not typical of a CAPS satellite.* | | | |
| **Mean motion difference rate (Delta Ndot)** | Units: semi-circles per (second)$^2$ | Range: ±2.91 E-11 semicircles.s$^{-2}$ | Default: 0 |

#### 17.4.1.1 Buttons

***Note**: Currently, Spirent are not aware of a site where you can download TLE format files for the CAPS constellation*

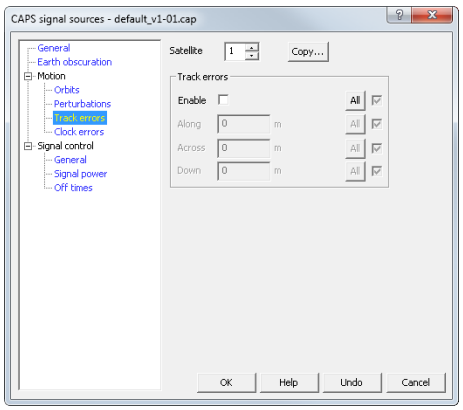
The buttons in the **Motion-Orbits** dialog are identical to those for GPS satellites, see **GPS-*Motion - Orbits*** (page 10-21).

### 17.4.2 Motion - Perturbations

This dialog is the same as **GPS-*Motion - Perturbations*** (page 10-34), except the range of Cuc, Cus, Cic and Cis is -61.035 16 to +61.033 29 microradians.

### 17.4.3 Motion - Track errors

This dialog is the same as **GPS-*Motion - Track errors*** (page 10-35), although parameter values may not be the same.




### 17.4.4 Motion - Clock errors

***Note**: Setting the **Delta Af0** clock divergence term is the same as applying a pseudorange error to that satellite.*

This dialog is the same as **GPS-*Motion - Clock errors*** (page 10-37), although parameter values may not be the same.

## 17.5 Signal control

Use the dialogs in the following sections to enter signal parameters for each CAPS satellite.

### 17.5.1 Signal control - General

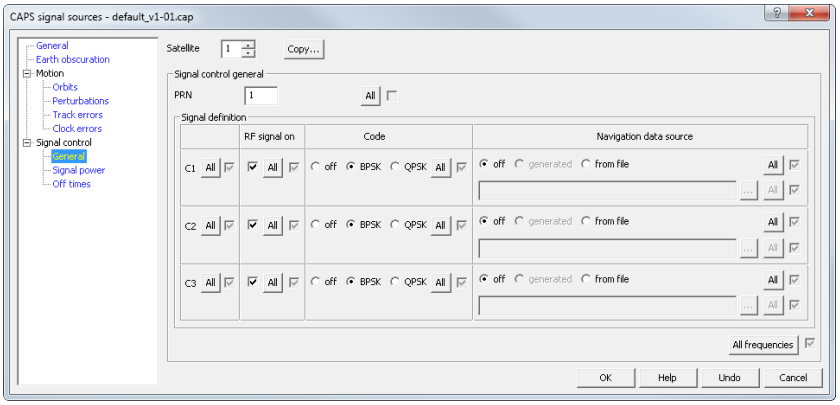
***Notes**:*


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***1)*** *Selecting* ***Code-QPSK*** *increases the RF power output power of the signal generator by 3 dB*

***2)*** *CAPS RF power levels in* ***Power Levels Graph*** *(page 3-9) do not show an increase in RF power level when using* ***Code-QPSK*** *- you must add 3 dB to the RF power level shown for the channel using* ***Code-QPSK***

Use this dialog to specify characteristics of the CAPS signal:




| | | |
|---|---|---|
| **Satellite** | Select the CAPS satellite whose settings you want to change. | |
| **Signal control general** | | |
| **PRN** | Set the PRN of **Satellite** | Range: 1 to 7 |
| **Signal definition** | For each of signals **C1**, **C2** and **C3**<br>Click **All** to use the current settings for **C1**, **C2** or **C3** for all satellites | |
| **RF signal on** | Select (default): RF signal on<br>Deselect: RF signal off<br><br>**All** (satellites) selected by default | |
| **Code** | Choose from:<br>**off**<br>**BPSK** (default)<br>**QPSK**<br><br>**All** (satellites) selected by default | |
| **Navigation data source** | Choose from:<br>**off** (default) navigation data not broadcast<br>**generated**: disabled<br>**from file**: click … and select the navigation data file.<br>The default location of these files is the folder<br>*Positioning Application\CAPS_data_sets*<br><br>***Navigation data source file*** formats gives details of these file formats.<br><br>Click **All** to use the same navigation data source ( **off**/**from file**) for all **Satellites**<br><br>**All** (next to filename browse button) is selected by default (so that all satellites use the same navigation data file) | |
| **All frequencies** | Click to copy the current settings to all satellites | |


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#### 17.5.1.1 Navigation data source file formats

Currently SimGEN does not generate CAPS navigation data; you must supply this data in a file.

Save the navigation data file in the folder *…/CAPS_data_sets*

Navigation data files use these extensions:

| Signal | Navigation data file extension |
|---|---|
| C1 | **.c1_nav* |
| C2 | **.c2_nav* |
| C3 | **.c3_nav* |

Navigation file details:

- The first line of the file must be the start time of the scenario (or time of applicability) and must use this format: DD-MMM-YYYY HH:MM:SS.
- You must identify comments using '!' at the start of the commented line.
- Navigation data must consist of 300 bits (75 hexadecimal characters) per sub-frame, per line.
- The 300 bits take 6 seconds to transmit (50 bits per second) and represent the navigation data stream after passing through the FEC encoder and interleaving.

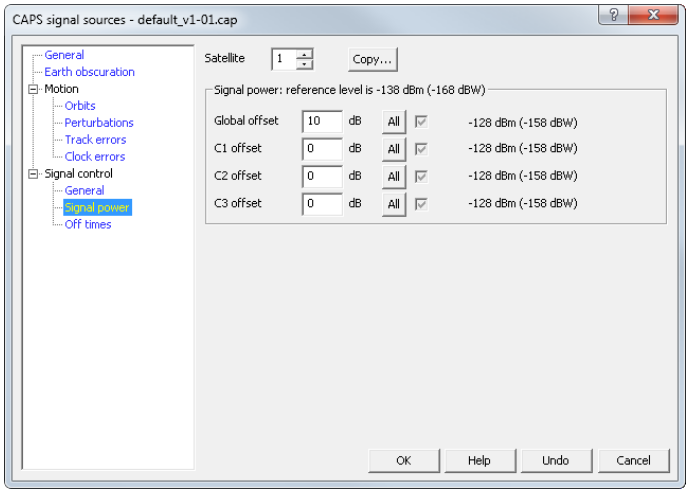
SimGEN re-cycles the navigation files throughout the scenario, so there is no requirement to make this file last for the length of the scenario.

For example:

```
05-Jul-2009 20:10:00
! Complete nav data messages each containing 600 symbols, or 150 hex chars
111110123456789012345678901234567890123456789012345678901234567890……1234567890123456789
211110123456789012345678901234567890123456789012345678901234567890……1234567890123456789
```

### 17.5.2 Signal control - Signal power

Use this dialog to control the signal level characteristics of all simulated carrier frequencies at the RF output of the RF Upconverter:




If you select **<scenario name>-signal sources file-*General*-Signal Strength-Modelled**, SimGEN applies the values you enter in this dialog before performing modelling.

| | |
|---|---|
| **Satellite** | Select the **Satellite** whose settings you want to change |
| **Signal power** | ***Note**: For all signals, the power level SimGEN applies is shown to the right of **All***<br><br>Set the signal power offsets from the CAPS reference level of -138 dBm |
| **Global offset** | Type the Global offset with respect to the reference level |


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| | | | |
|---|---|---|---|
| | Units: decibels | Range: -20.0 to +20.0 dB | Default: 10 |
| **C1 offset, C2 offset** and **C3 offset** | Type the relative power offset for each of **C1**, **C2** and **C3** | | |
| | Units: decibels | Range: -20.0 to +20.0 dB | Default: 0 |

Click **All** to apply that power level offset to all CAPS satellites.

## 17.6 Signal control - Off times

This dialog is the same as **GPS-*Signal Control - Off times*** (page 10-50).

## 17.7 PRN codes

***Notes**:*

***1)** The signal generator does not permanently store these PRN codes. They are lost when you turn off ac power to the signal generator*

***2)** Spirent does not supply example PRN files.*

***3)** Reference x) details the format of the PRN file. You must save the PRN file with the filename, and in the location, this section defines.*

To assign a PRN to a satellite, open ***Signal control - General*** and type the PRN for the satellite in **PRN**. You can assign one PRN to be used for all satellites (by clicking **All**), or you can assign a different PRN for each satellite (by typing the PRN for each satellite SVID).

### 17.7.1 Filename and location

This table details the PRN filenames. You must use the filenames for the modulation type as shown.

| Modulation type | Filename |
|---|---|
| BPSK | *caps_prns_C1_IP.dat* |
| | *caps_prns_C2_IP.dat* |
| | *caps_prns_C3_IP.dat* |
| QPSK | *caps_prns_C1_QP.dat* |
| | *caps_prns_C2_QP.dat* |
| | *caps_prns_C3_QP.dat* |

Save these files in the folder (which you must first create):
*…/CAPS_data_sets*

The file for each PRN consists of a string of 10 230 bits represented as 2 558 hexadecimal characters.


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# 18 BeiDou constellation editor

***Licenced feature**: You will need a licence to use this feature. Contact Spirent for licencing details.*

***Notes**:*

***1)** BeiDou time lags GPS time by 14 seconds, for example: 23:58:00 (BeiDou time) is 23:58:14 (GPS time)*

***2)** During extensive testing, Spirent have observed that for a scenario configured to start at midnight, one receiver tracks the visible satellites but does not provide a navigation solution; whereas a receiver from a different manufacturer provides a navigation solution.*
*Currently, Spirent presume this is a receiver issue and recommend you contact Spirent Global Services if you intend using scenarios that start at midnight.*

The BeiDou Phase II constellation currently offers a limited global GNSS service from satellites in inclined geo-stationary, geostationary and medium earth orbits. BeiDou signals will provide a free civilian service and a restricted government service.

Reference aa) gives the BeiDou ICD version 2.0, which defines the B2 signal component. Currently, reference aa) does not define B3 and Spirent provides navigation data content for B3 that is identical to B1 (unless you use navigation data from a file, see ***Navigation data*** (page 18-7).

This table gives the BeiDou constellation signals, frequencies and reference levels.

| Signal | Centre frequency, MHz | Power reference level, dBm |
|---|---|---|
| B1 | 1 561.098 | -133 |
| B2 | 1 207.14 | -133 |
| B3 | 1 268.52 | -133 |

## 18.1 PosApp

PosApp is the generic name for the suite of software Spirent uses in their range of Satellite Navigation Simulator products. SimGEN is Spirent's software for simulating GNSS signals when used with a suitable signal generator.

SimGEN version 4-02 onwards supports the BeiDou constellation signals B1 and B2 for an GSS8000-series signal generator only when using:

- Signal generator card firmware version 2-25 (or later)
- FPGA image release 32 (or later)
- A correctly installed licence file

SimGEN version 4-04SR01 onwards supports the BeiDou constellation signals B1, B2 and B3 for an GSS8000-series signal generator only when using:

- Signal generator card firmware version 2-36 (or later)
- FPGA image release 36 (or later)
- A correctly installed licence file

To find the firmware version and FPGA image of your GSS8000-series signal generator cards and then determine if your signal generator needs upgrading, Spirent recommends you follow this procedure:

- Read the section on the menu item **Options-*Hardware Configuration*** (page 5-18), then display your signal generator configuration
- Select your signal generator
- Click **Output details…**
- Contact Spirent Global Services and provide the relevant details from the configuration window.


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→ Spirent Global Services will then determine if your signal generator needs upgrading and provide details on the upgrade procedure.

Spirent's GSS7000 signal generator, with SimGEN verison 6-00 onwards, support BeiDou constellation signals B1 and B2.

Spirent's GSS9000-series signal generator, with SimGEN verison 5-00 onwards, support BeiDou constellation signals B1, B2 and B3.

Spirent's GSS6700 signal generator using either PosApp or SimREPLAY/SimREPLAYplus - see reference xx); and the GSS6300-family of signal generators using Spirent's SimCHAN software - see reference jjj), also support BeiDou.

The BeiDou constellation editor is similar to the ***GPS constellation editor*** (page 10-1). If this Chapter on the BeiDou constellation editor does not give details for a scenario parameter, see the details for the parameter with the same name in the ***GPS constellation editor***.

The **BeiDou constellation-Signal sources file** characterises the BeiDou satellites in a simulation. This file is often known as the "BeiDou Constellation file", and is one of the source files defining a scenario. The default signal sources filename for the BeiDou constellation is *default_vx-yy.cmp*, where *yy is* the version number.

Notice that BeiDou signal sources files up to *default_v1-05.cmp* disable BeiDou B3 by default to provide backwards compatibility, whereas BeiDou signal sources file *default_v1-05.cmp* onwards enables BeiDou B3 by default.

To use the BeiDou constellation, first see **Receive and transmit antennas-*Associate a GNSS signal with an antenna*** (page 23-4) and associate the BeiDou signal with the antenna(s) you want to use.

## 18.2 BeiDou constellation editor

***Notes**:*

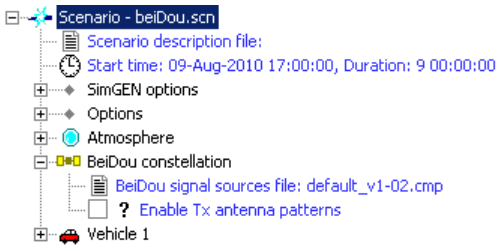
***1)** The range of parameter values you can enter in SimGEN may be different from the values commonly used in satellite navigation systems.*

***2)** To limit CPU processing at the start of a run, SimGEN assigns any values you enter in **Motion - Perturbations** (page 18-16) as follows:*
*Up to three days either side of the orbit **Reference time**, set using **Motion - Orbits** (page 18-16), SimGEN assigns the **Perturbation** values you enter with respect to the **Reference time**.*
*Over three days from the orbit **Reference time**, SimGEN assigns the **Perturbation** values you enter to the cutover preceding the scenario **Start time**.*

Use the constellation editor to edit data in the BeiDou constellation file. The editor shows the data in the BeiDou constellation file as a series of "pages". The left-hand area shows the pages you can select for editing; the right-hand area shows the details of the page you selected in the left-hand area. This section describes how you select and change details in the right-hand area.

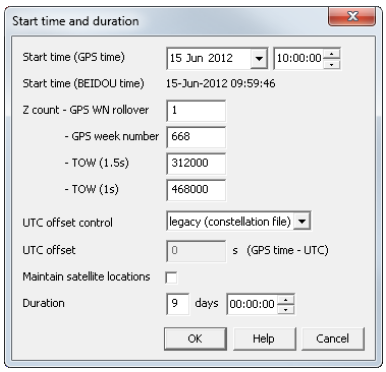
SimGEN checks the range of the value you type in a text box and, if incorrect, displays the range of acceptable values.

After associating the BeiDou signal type with an antenna, the BeiDou constellation file appears in the **Scenario contents** window:




Double-clicking **Start time** shows the **Start time and duration** dialog, which shows start time in both GPS and BeiDou time:

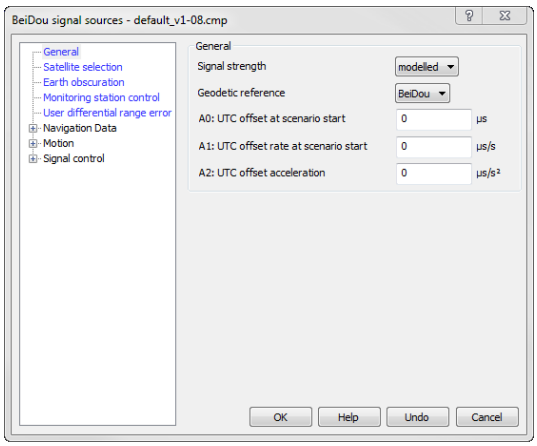

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**Receive and transmit antennas-*Transmitter antenna level and phase*** patterns (page 23-20) details creating and applying **Tx antenna patterns**.

Edit the BeiDou constellation file in the same way as you would edit a GPS constellation file. First, expand **BeiDou constellation**. Then:

- Select **BeiDou constellation-Signal sources file**
- Right-click and select **Edit**
- You will see the **Signal sources-General** dialog, shown below. The BeiDou signal sources file has the default name *default_vx-yy.cmp*.

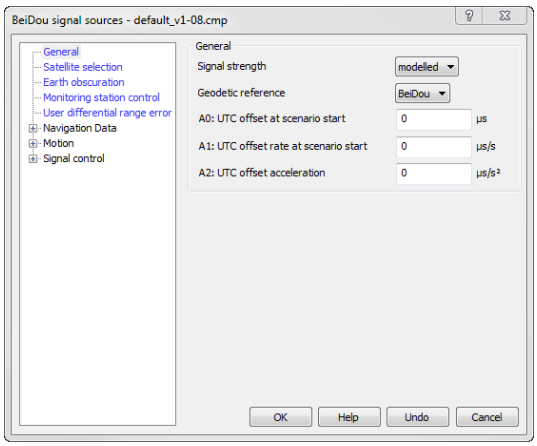



The left-hand area of the **Signal sources** dialog shows the titles of all “pages” you can edit in the file. Click on a title to edit it.

After editing the **Signal sources file** click **OK**, then save the file to a name of your choice using the dialog. Select **Shared** to save this file to the shared folder, so making it available to other scenarios.

## 18.3 General

Use the **General** dialog to edit parameters affecting all BeiDou satellites.



| | | | |
|---|---|---|---|
| **Signal strength** | Select whether SimGEN modifies satellite signal-levels based on satellite-to-antenna distance or uses a fixed signal level. **GPS-*General - Modelled and fixed signal strength*** (page 10-8) gives further details on Modelled and Fixed. In each case, first set the base RF power level using ***Signal control - Signal power*** (page 16-18) | | |
| **Modelled** | (default) SimGEN modifies satellite signal level as a function of the satellite to receiver antenna distance in proportion to 1/(distance)$^2$ | | |
| **Fixed** | SimGEN does not modify the signal level as a function of satellite to receiver antenna distance. | | |
| **Geodetic reference** | Defines the gravitational constant and the characteristic parameters of the Earth ellipsoid used to propagate the satellite orbits.<br>Choose from:<br>**BeiDou** (default) uses China Geodetic Coordinate System 2000 (CGS2000)<br>**GPS** uses the GPS coordinate system (WGS-84) | | |
| **A0: UTC offset at scenario start** | Units: microseconds | Range: ±100 μs | Default 0 |
| **A1: UTC offset rate at scenario start** | Units: microseconds per second | Range: ±0.0074 μs.s$^{-1}$ | Default: 0 |
| **A2: UTC offset acceleration** | Units: microseconds per (second)$^2$ | Range: -2.17 E-13 to 2.13 E-13 μs.s$^{-2}$ | Default: 0 |
| ***Note**: UTC offset is with respect to BeiDou system time* | | | |
| **UTC offset at scenario start** | Offset between Compass system time and UTC | | |
| **A0: offset** | Units: microseconds | Range: -100 to +100 μs | Default: 0 |
| **A1: offset rate** | Units: microseconds per second | Range: -0.007 4 to +0.007 4 μs.s$^{-1}$ | Default: 0 |
| **A2: offset acceleration** | Units: microseconds per (second)$^2$ | Range: -2.17 E -13 to +2.13 E -13 μs.s$^{-2}$ | Default: 0 |

## 18.4 Satellite selection

This dialog is the same as the **GPS-*Satellite selection*** (page 10-10).

## 18.5 Earth obscuration

This dialog is the same as the **GPS-*Earth obscuration*** (page 10-11).

## 18.6 Monitoring station control

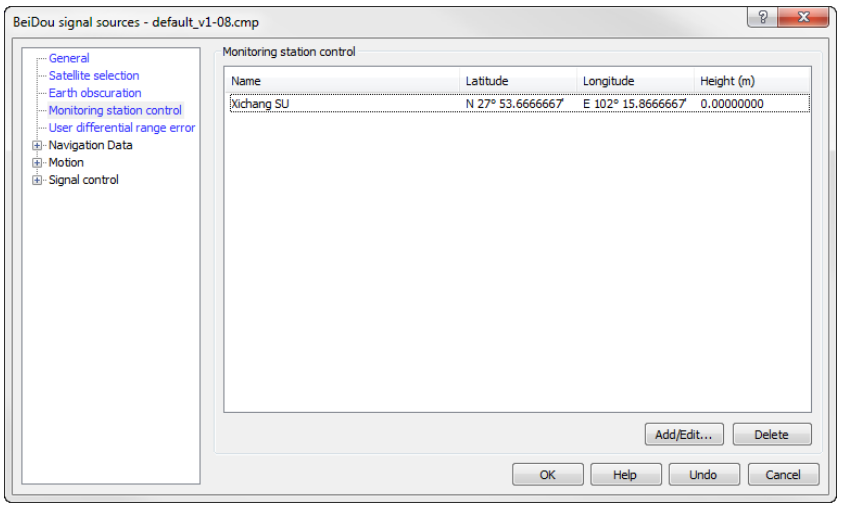
***Note**: SimGEN requires Line-of-Sight visibility to at least one BeiDou monitoring station*

BeiDou monitoring stations collect data for all the BeiDou satellites in view from each monitoring station location. The monitoring stations determine the values of certain navigation data parameters that BeiDou satellites will broadcast in the D2 navigation message.

Use this dialog to enter or edit details of monitoring stations:

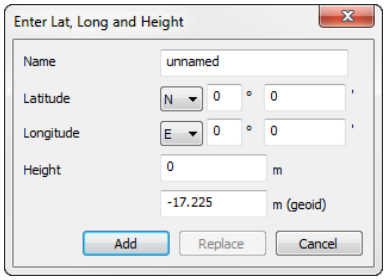


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To enter the location of a monitoring station:

→ Click **Add/Edit…** to open the **Enter Lat**, **Long and Height** dialog shown below.




| | | | |
|---|---|---|---|
| **Name** | Type a name for the new monitoring station | | |
| **Latitude** | Type the position of the new monitoring station | | |
| | Units: degrees, minutes | Range: N 90° 0.0´ to S 90° 0.0´ | |
| **Longitude** | Type the position of the new monitoring station | | |
| | Units: degrees, minutes | Range: W 180° 0.0´ to E 180° 0.0´ | |
| **Height** | Type the height of the new monitoring station | | |
| | Units: metres | Range: -9 999 to +30 000 m | Default: 0 (-18 geoid) |

→ Click **Add** after completing the entries in the dialog.

To edit the data of an existing monitoring station, select the station and click **Edit**.

To delete a monitoring station, select the station and click **Delete**.

## 18.7 User differential range error

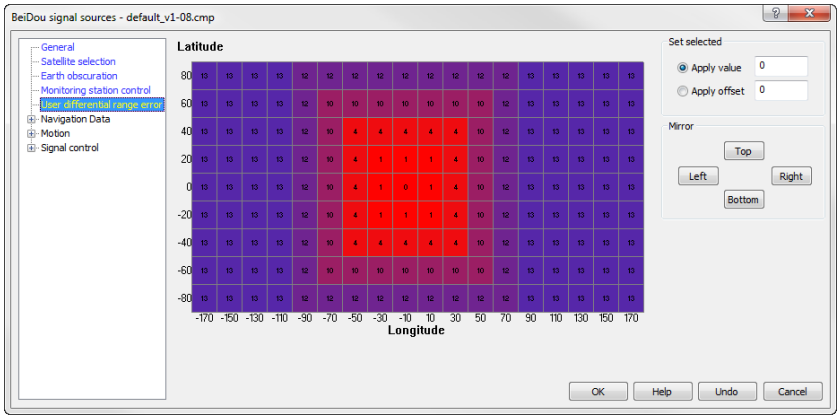
***Notes**:*

***1)** Applicable error limits and the methods used in SimGEN may not exactly represent those used by the BeiDou system, but they do fulfil the purpose of automatically providing realistic user differential range error data as a function of the relative geometry of the ground stations and the satellites being tracked.*

***2)** SimGEN does not automatically generate BeiDou user differential range error data, you must select the data for each satellite to broadcast*

The user differential range error, broadcast in the BeiDou D2 navigation message, indicates the accuracy of the correction data for individual satellites. The applicable value depends on the relative geometry of the monitored satellite and the ground stations for which this is visible.

Use this dialog to enter the latitude and longitude values at the centre of each cell:



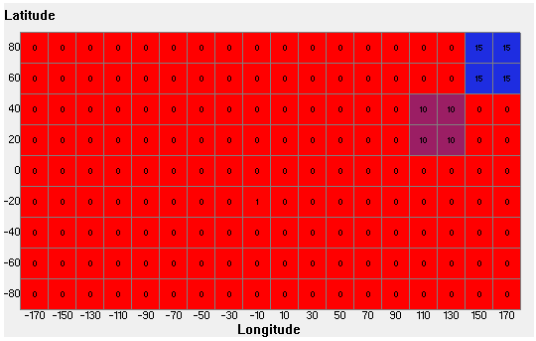

To enter a value for the user differential range error (which must be an integer between 0 and 15):

- Select **Set selected-Apply value**.
- Type the **user differential range error** you want to use in the text box.
- Click in the cells where you want to apply this user differential range error.
- You can also drag across multiple cells to enter this user differential range error in more than one adjacent cell.

To offset the user differential range error from those already present (the offset must be an integer between -15 and 15):

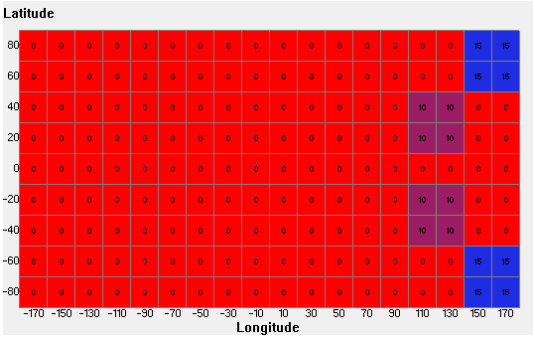
- Select **Set selected-Apply offset**.
- Type the user differential range error offset you want to use in the text box.
- Click in the cell where you want to offset the current user differential range error by your chosen amount
- You can also drag across multiple cells to offset by this value in more than one adjacent cell
- Values on cell boundaries correspond to the higher latitude / longitude. The figure below shows how you use the **Mirror** buttons to apply values or offsets about the cell with latitude = 0° or the cell boundary at -10° and 10° corresponding to longitude = 0°.

For example, enter the values you want to use in the top right-hand quadrant:

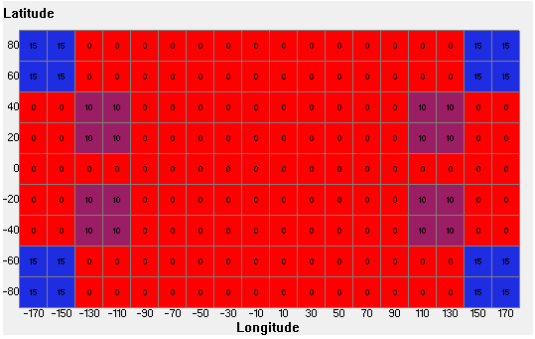



Click **Top** to mirror the values you entered to the bottom right-hand quadrant:


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Click **Right** to mirror the values on the right-hand side to the left-hand side:




Lower user differential range errors will apply in the general vicinity of the monitoring station locations. The grid value appropriate to the current position of a satellite, in terms of latitude and longitude, determines the user differential range error it uses.

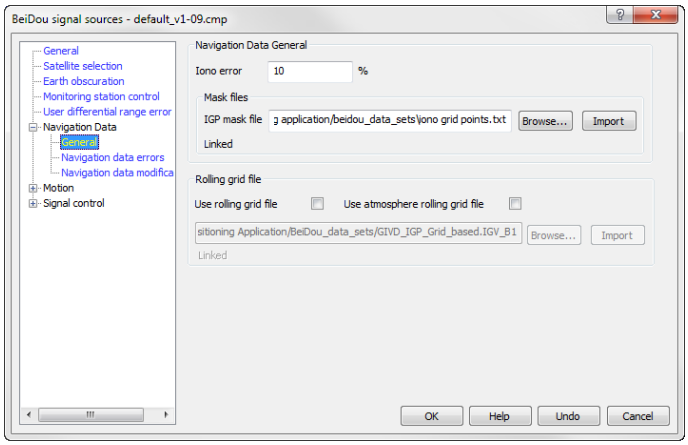
## 18.8 Navigation Data

You can apply separate navigation data errors and modifications to navigation data types D1 (MEO and IGSO satellites) and D2 (GEO satellites). References y) and aa) define D1 and D2. SimGEN applies these errors and modifications to both B1 and B2 signals.

### 18.8.1 General

Use the **General** dialog to set ionospheric errors using the Klobuchar model with an Ionospheric Grid Point (IGP) mask file.

As an alternative to using the Ionospheric Grid Point mask fil, you can use a rolling grid file that contains a series of time-dependant values for GIVD (vertical ionospheric delay in metres) and GIVEI (the error index) at specific locations.




| | |
|---|---|
| **Iono error** | Defines the percentage error SimGEN applies to all atmospheric delay measurements. SimGEN uses this to determine GIVEI indexes at each iono monitoring point in use. 0% shows a high confidence in the error, 100% shows a low confidence in the error. |


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| | | | |
|---|---|---|---|
| | Units: percent | Range: 0 to 100 % | Default: 10 |
| **IGP mask file** | Select the file defining the locations of the valid points in the BeiDou Ionospheric Grid Mask.<br>Click the browse button,  and navigate to the location of the IGP mask file you want to use. Spirent provides the file *iono grid points.txt* in the default location *… /beidou_data_sets/*<br><br>***Iono grid-point format*** defines the format of the BeiDou grid-point file. | | |
| **Rolling grid file** | Selecting **Use rolling grid file** in the **BeiDou-signal sources file** results in broadcast of the ionospheric delays in the navigation message.<br>Selecting **Use atmosphere rolling grid** uses the rolling grid file you define in **Atmosphere-*Terrestrial iono model - GPS and default model*-Use rolling grid file** (page 9-3) to calculate both the delays broadcast in the navigation data message and the ionospheric delays present in the simulated RF signal. | | |
| **Use rolling grid file** | Deselect (default): uses the BeiDou Klobuchar model to determine Ionospheric delay and GIVEI<br>Select: Uses a grid-based ionospheric model according to the rolling grid file you select.<br>By default this area shows the location of the default grid data file *GIVD_IGP_Grid_based.IGV_<frequency>*<br>that Spirent provides; where *<frequency>* indicates the frequency the ionospheric delay, as follows:<br>1) **.IGV_B1* (and **.IGV*) is a data file with delay values with respect to B1.<br>When the rolling grid file provides ionospheric delays with respect to B1 for a satellite broadcasting on B2 or B5, SimGEN scales the ionospheric delays to B2 or B5 and then applies the delay values to the navigation data message.<br>2) **.IGV_B2* is a data file with delay values with respect to B2.<br>**.IGV_B5 is* a data file with delay values with respect to B5.<br>When the rolling grid file provides ionospheric delays with respect to a frequency other than B1, SimGEN first scales the delays to B1; then scales from B1 to the frequency the satellite is using; and finally applies the delay values to the navigation data message.<br><br>This file has these default locations:<br>C50r SimGEN Host:<br>*D:\posapp\software\<version>\gui\BeiDou_data_sets*<br>SimGEN Controller:<br>*C:\Program Files\Spirent Communications*<br>*Positioning Application\BeiDou_data_sets*<br><br>***Rolling grid iono file format*** (page 9-9) describes the file format<br><br>Click **Browse…** to navigate to an “external” rolling grid file you want to use. The location of this file can be any folder on your C50r SimGEN Host or SimGEN Controller. The text “Linked” shows SimGEN links the file shown to the scenario.<br>Click **Import** to navigate to a rolling grid file, as when clicking **Browse…**<br>However, when you click **Open** in the dialog and select a file, SimGEN will import this file into the same folder as the file referencing it. This may be a scenario file (**.scn*) or the ‘shared’ folder; but, it is more likely to be a scenario source file, such as the signal sources file (**.cmp*) here. SimGEN automatically updates the path to the file.<br>The text “Importing” shows SimGEN will import the rolling grid file you select, rather than referencing the file from its original location.<br>Notice SimGEN completes the import of the file when you click **OK** and save the new signal sources file to a name of your choice.<br>Subsequently, when you open this signal sources file, the rolling grid file you selected appears in the text area without a pathname, since it is present in the scenario folder.<br>The text “Linked” shows SimGEN links the file shown to the scenario. | | |

***Notes**:*

***1)** Selecting **Use rolling grid file** applies the ionospheric delay only to the navigation data message*

***2)** For the BeiDou constellation, the navigation data message always broadcasts ionospheric delays with respect to B1*

***3)** You can only **Import** a rolling grid file*


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#### 18.8.1.1 Iono grid-point format

***Note**: If SimGEN cannot open or locate an iono grid point (IGP) mask file, it cannot broadcast Ionospheric correction messages and gives an error message*

The BeiDou ionospheric grid point mask (IGP Mask MT5) defines the grid locations, which reference aa) defines, that provide ionospheric correction information. Spirent supplies the text file *iono grid points.txt* (default location …*beidou_data_sets*\) that contains all grid points in reference aa).

You can prepare a new mask file, using a name of your choice, that contains a subset of the grid points in reference aa). Notice you cannot add grid points that reference aa) does not define. If you use a mask file you generate, SimGEN will only use the grid points in this file and will disable the missing grid points.

The BeiDou navigation data message broadcasts GIVD (Grid Ionosphere Vertical Delay, in metres) and GIVEI (the Grid Ionosphere Vertical Error Index - see reference aa).

Example partial listing of *iono grid points.txt*:

"!" at the start of a line indicates a comment.

Data lines specify the grid-point parameters, using this format:

→ Longitude index (integer, 0 to 31) longitude (floating, degrees) latitude (floating, degrees)

A single space separates the parameters.

You only need enter data you want to use; SimGEN sets missing data to "off".

```
! Column order: longitude index, longitude value, latitude value

0 70.0 10.0
0 70.0 15.0
0 70.0 20.0
0 70.0 25.0
0 70.0 30.0
0 70.0 35.0
0 70.0 40.0
0 70.0 45.0
0 70.0 50.0
0 70.0 55.0

1 75.0 10.0
1 75.0 15.0
1 75.0 20.0
1 75.0 25.0
1 75.0 30.0
1 75.0 35.0
1 75.0 40.0
1 75.0 45.0
1 75.0 50.0
1 75.0 55.0

2 80.0 10.0
2 80.0 15.0
.
.
```

### 18.8.2 Navigation data errors

***Notes**:*

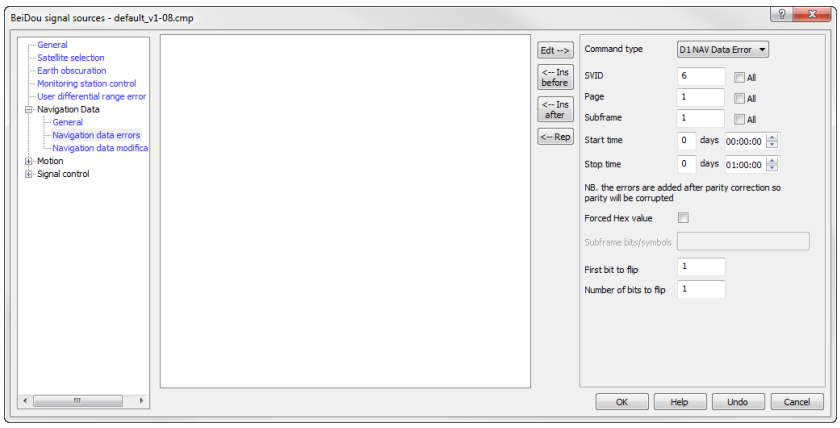
***1)** SimGEN calculates parity BEFORE making the changes, so SimGEN transmits data with incorrect parity. This tests the error detection and correction algorithms of your receiver.*

***2)** To see the Help file topic on Navigation data errors for this constellation, Spirent recommend you select the Help topic from the **SimGEN Help-Contents** tab; clicking **Help** or pressing F1 on your keyboard may display an invalid Help topic.*

Use this dialog to enter BeiDou navigation data errors for the navigation data types D1 (MEO and IGSO satellites) and D2 (GEO satellites).

Notice the defaults and ranges of certain parameters vary between D1 and D2.


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| | | | |
|---|---|---|---|
| **Command type** | Select from: **D1 NAV Data Error** or **D2 NAV Data Error** | | |
| **SVID** | Type the SVID you want to use or select **All** | | |
| | | Range: 6 to 30 (D1)<br>1 to 5 (D2) | Default: 6 (D1)<br>1 (D2) |
| **Page** | Type the Page number or select **All** | | |
| | | Range: 1 to 24 (D1)<br>1 to 120 (D2) | Default: 1 (D1 and D2) |
| **Subframe** | Type the Subframe number or select **All** | | |
| | | Range: 1 to 5<br>(D1 and D2) | Default: 1 (D1 and D2) |
| **Start time**<br>**Stop time** | Units:<br>d hh:mm:ss | Range:<br>0 days 00:00:00<br>to 23 days 23:59:59 | **Start** default:<br>0 days 00:00:00 (start of run)<br>**Stop** default:<br>0 days 01:00:00 |
| **Forced Hex value** | Specify hexadecimal characters to use for the subframe message.<br><br>(default) deselected: enables **First bit to flip** and **Number of bits to flip**<br>disables **Subframe bits/symbols**<br><br>Select: enables **Subframe bits/symbols**<br>disables **First bit to flip** and **Number of bits to flip** | | |
| **Subframe bits/symbols** | Type a maximum of 75 hexadecimal characters (click **OK** to dismiss the reminder) | | |
| ***Note**: SimGEN adds trailing zeroes to the characters you enter to make up the number of characters to 75* | | | |
| **First bit to flip** | Type the first symbol of the 300 broadcast bits to invert (flip) | | |
| **Number of bits to flip** | Type the number of bits in the message to invert (flip) | | |

### 18.8.3 Navigation data modification

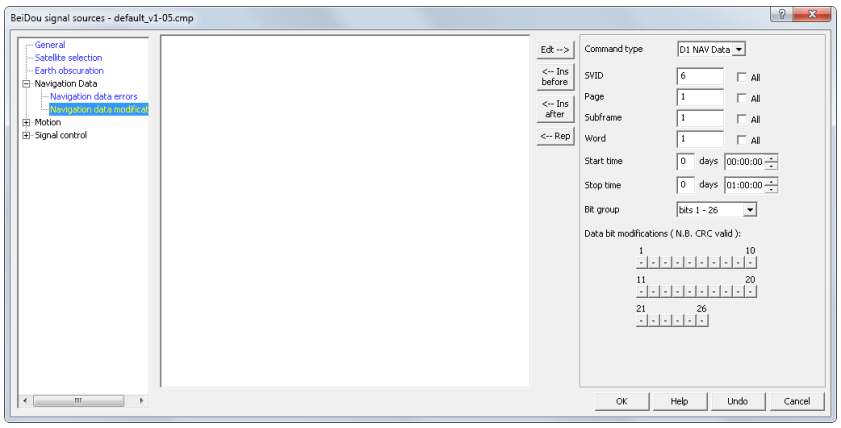
***Note**: To see the Help file topic on Navigation data modification for this constellation, Spirent recommend you select the Help topic from the **SimGEN Help-Contents** tab; clicking **Help** or pressing F1 on your keyboard may display an invalid Help topic.*

Use this dialog to modify BeiDou navigation data for the navigation data types D1 (MEO and IGSO satellites) and D2 (GEO satellites).

Notice the defaults and ranges of certain parameters vary between D1 and D2.

SimGEN applies these modifications before calculating parity.


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| | | | |
|---|---|---|---|
| **Command type** | Select from: **D1 NAV Data** or **D2 NAV Data** | | |
| **SVID** | Type the SVID you want to use or select **All** | | |
| | | Range: 6 to 30 (D1)<br>1 to 5 (D2) | Default: 6 (D1)<br>1 (D2) |
| **Page** | Type the Page number or select **All** | | |
| | | Range: 1 to 24 (D1)<br>1 to 120 (D2) | Default: 1 (D1 and D2) |
| **Subframe** | Type the Subframe number or select **All** | | |
| | | Range: 1 to 5<br>(D1 and D2) | Default: 1 (D1 and D2) |
| **Word** | Type the Word number or select **All**<br>Word 1 uses bits 1 to 26 for data and 4 bits of for parity (30 bits total)<br>Words 2 to 10 use bits 1 to 22 for data and 8 bits for parity (30 bits total)<br><br>Notice:<br>1) Typing **Word-1**then selecting **Word-All** applies the **Data bit modifications** you make to all **Words**. The dialog displays **Bit group-bits 1 to 26** and shows **Data bit modification** for **bits 1 to 26**. In this case, **Word-2** to **Word-10** will disregard any selection you make for **bit 23** to **bit 26**.<br><br>2) Typing **Word-2** to **Word-10**, then selecting **Word-All** applies the **Data bit modifications** you make to all **Words**. The dialog displays **Bit group-bits 1 to 22** and shows **Data bit modification** for **bits 1 to 22**. In this case, however, **Word-1** will not include any modifications for **bit 23** to **bit 26**.<br>Spirent recommends you create a separate command to set **bits 23** to **bit 26** for **Word-1**. | | |
| | | Range: 1 to 10<br>(D1 and D2) | Default: 1 (D1 and D2) |
| **Start time**<br>**Stop time** | Units:<br>d hh:mm:ss | Range:<br>0 days 00:00:00<br>to 23 days 23:59:59 | **Start** default:<br>0 days 00:00:00 (start of run)<br>**Stop** default:<br>0 days 01:00:00 |
| **Bit group** | Fixed at **bits 1 - 26** for **Word-1** and **bits 1 - 22** for **Word-2** to **Word-10** | | |
| **Data bit modification** | Modify each bit in the **Bit group** by clicking on the appropriate button. This table (page 10-16) details the symbols on each button.<br>The default is “leave bit as is” | | |


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## 18.9 Motion

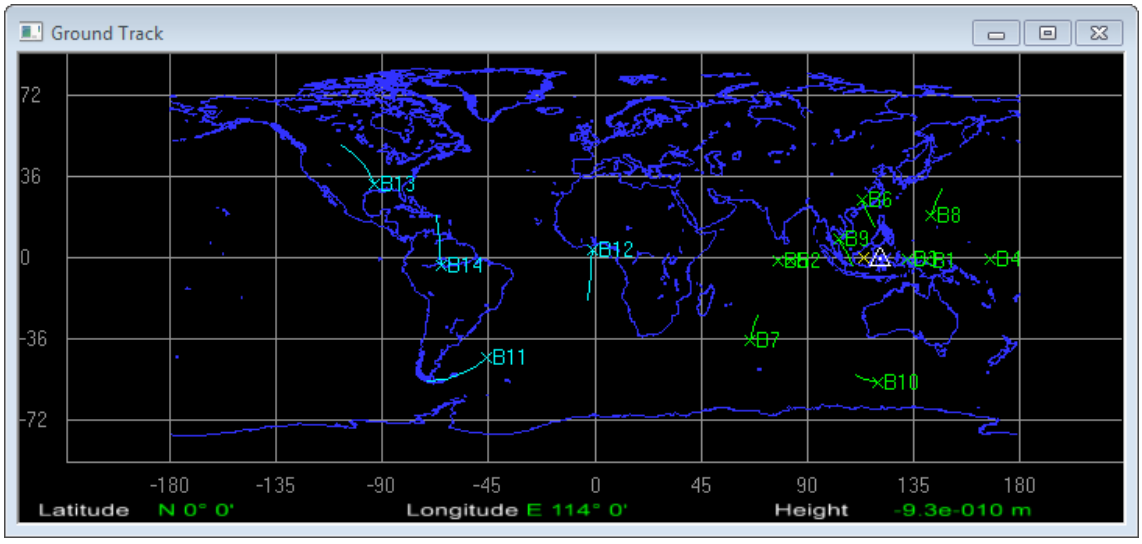
***Note**: Currently, reference y) defines the longitude of the ascending node for the five geo-stationary satellites. Spirent defines orbital parameters for the remaining geosynchronous and medium earth orbit satellites to give typical orbits.*

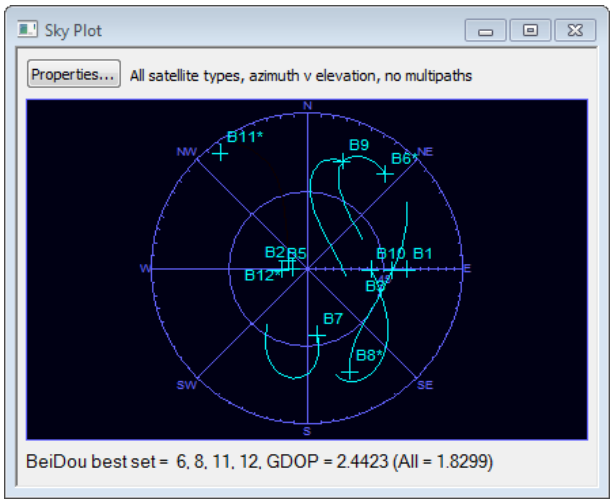
You can define orbits for up to 30 BeiDou satellites. By default, Spirent enables the first 14 satellites (selected, by default, in ***Motion - Orbits*-Present** (page 18-13)) as follows:

| Satellite type | Parameter |
|---|---|
| Geo-stationary (GEO) | Satellites: 1 to 5<br>Locations: 58.75°E, 80°E, 110.5°E, 140°E and 160°E (satellites 1 to 5 respectively)<br>Altitude: 35 786 km |
| Inclined geo-synchronous (IGSO) | Satellites: 6 to 10<br>Altitude: 35 786 km<br>Inclination: 55° |
| Medium earth orbit (MEO) | Satellites: 11 onwards<br>Altitude: 21 528 km<br>Inclination: 55° |

Currently, Spirent defines the remaining 16 (disabled) satellites as MEO satellites with distributed, but not optimal, orbits.

The two figures below show the SimGEN **Ground Track** and **Sky Plot** windows after running a BeiDou scenario with a static vehicle located on the equator at 114° East.





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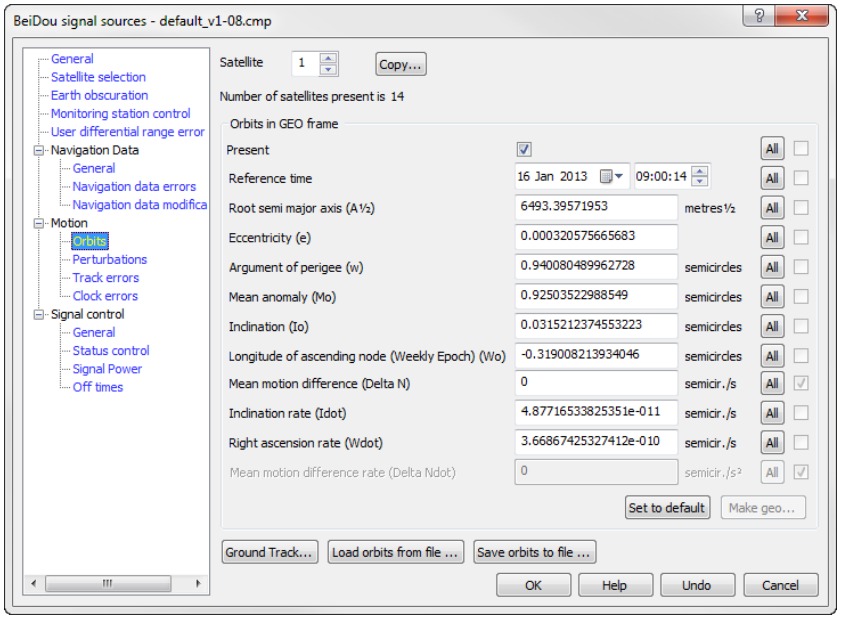
## 18.9.1 Motion - Orbits

***Notes**:*

***1)** Spirent recommends you change default values with care.*

***2)** Converting GEO satellites (in the GEO frame) to the ECEF frame forces the parameters **Inclination rate**, **Right ascension rate** and **Mean motion difference**, to zero.*

Use this dialog to specify orbital parameters for each BeiDou satellite. This dialog shows the default parameters for **Satellite 1** (a GEO satellite) - the dialog indicates the satellite orbit type with the text **Orbits in GEO frame** at the top of the area:



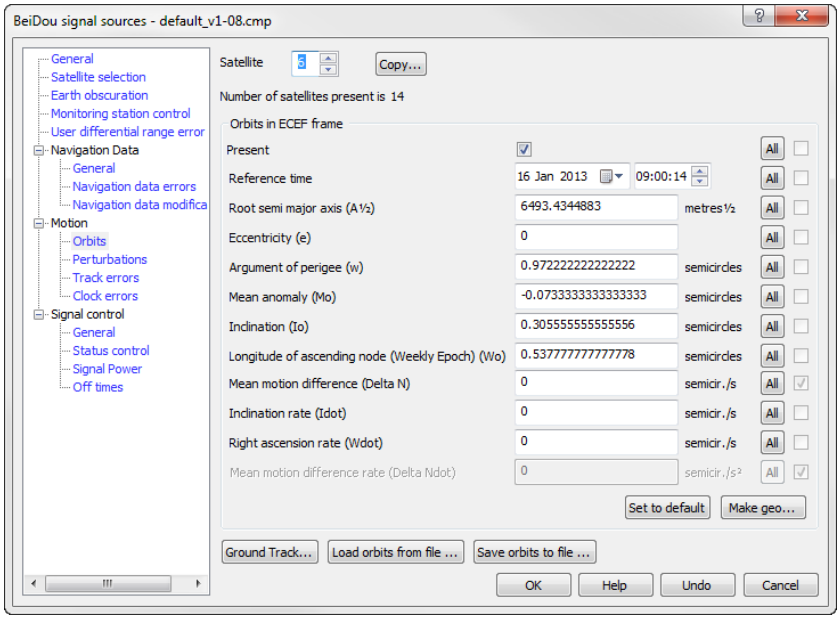

As you scroll through the satellites, using the arrow buttons on the right-hand side of the **Satellite** number, the orbital parameters alter accordingly. The dialog shows the **Number of satellites** present in the scenario (default 14).

This parameter table shows the parameters for GEO satellites, with the defaults for **Satellite 1**. Notice that SimGEN sets certain GEO satellite parameters to zero.

| | | | |
|---|---|---|---|
| **Satellite** | Enter the satellite number whose details you want to modify. This table shows defaults for **Satellite 1** (a GEO satellite) | | |
| **Present** | Select (by default, satellites 1 to 14 are **Present**): includes **Satellite** in the scenario<br>Deselect: treats **Satellite** as non-existent and does not include it in the Navigation data almanac set. | | |
| **Reference time** | This time is analogous to toe in the GPS satellite data message. | | |
| | Units: d hh:mm:ss.ss | Range: 01 January 2006 00:00:00.00 UTC to 23 January 2100 00:00:00.00 | |
| **Root semi major axis ($A^{½}$)** | Units: $metres^{½}$ | Range: 2 537.0 to 8 192.0 $m^{½}$ | Default: Approximately 6 493 for **Satellites 1** to **5** |
| **Eccentricity (e)** | Units: none | Range: 0 to 0.062499 | Default: Approximately 0.000 3 for **Satellites 1** to **5** |
| **Argument of perigee (w)** | Units: semi-circles | Range: -1 to +1 semi-circle | Default: 0.940 080 489 962 728 (varies with **Satellite**) |
| **Mean anomaly (Mo)** | Units: semi-circles | Range: -1 to +1 semi-circle | Default: 0.925 035 229 885 49 (varies with **Satellite**) |

| | | | |
|---|---|---|---|
| **Inclination (Io)** | Units: semi-circles | Range: -1 to +1 semi-circle | Default:<br>0.031 521 237 455 322 3<br>(varies with **Satellite**) |
| **Longitude of ascending node (Weekly Epoch) (Wo)** | Units: semi-circles | Range: -1 to +1 semi-circle | Default: -0.319 008 213 934 046<br>(varies with **Satellite**) |
| ***Note**: The reference time for **Wo** is the weekly epoch at or before the orbit reference time and is referenced to the BeiDou start of week* | | | |
| **Mean motion difference (Delta N)** | Units: semi-circles per second | Range: -3.725 29 E-9 to +3.725 177 E-9 semicircles.s$^{-1}$ | Default: 0 |
| ***Note**: Currently, SimGEN sets **Mean motion difference (Delta N)** to zero and ignores any value in this dialog* | | | |
| **Inclination rate (Idot)** | Units: semi-circles per second | Range: -9.313 227 8 E-10 to +9.312 088 9 E-10 semicircles.s$^{-1}$ | Default: 4.877 165 338 253 51e-011 |
| ***Note**: Currently, SimGEN sets **Inclination rate** to zero and ignores any value in this dialog* | | | |
| **Right ascension rate (Wdot)** | Units: semi-circles per second | Range: -9.536 742 8 E-7 to +9.536 742 E-7 semicircles.s$^{-1}$ | Default: 3.668 674 253 274 12e-010 |
| ***Note**: Currently, SimGEN sets **Right ascension rate (Wdot)** to zero and ignores any value in this dialog* | | | |

This dialog shows the default parameters for **Satellite 6** (an IGSO satellite) - the dialog indicates the satellite orbit type in the text **Orbits in ECEF frame** at the top of the area (MEO satellites are the same orbit type):




As you scroll through the satellites, using the arrow buttons on the right-hand side of the **Satellite** number, the orbital parameters alter accordingly. The dialog shows the **Number of satellites** present in the scenario (default 14).

This parameter table shows the parameters for GEO satellites, with the defaults for **Satellite 6**.

| | |
|---|---|
| **Satellite** | Enter the satellite number whose details you want to modify. This table shows defaults for **Satellite 6** (an IGSO satellite) |
| **Present** | Select (by default, satellites 1 to 14 are **Present**): includes **Satellite** in the scenario<br>Deselect: treats **Satellite** as non-existent and does not include it in the Navigation data almanac set. |


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| | | | |
|---|---|---|---|
| **Reference time** | This time is analogous to toe in the GPS satellite data message. | | |
| | Units: d<br>hh:mm:ss.ss | Range: 01 January 2006<br>00:00:00.00 UTC to<br>23 January 2100<br>00:00:00.00 | |
| **Root semi major axis ($A^{½}$)** | Units: $metres^{½}$ | Range: 2 537.0 to 8 192.0 $m^{½}$ | Default: approximately<br>6 493 for **Satellites 6** to **10**, In range 5 150 to 5 290 for **Satellites 11** on |
| **Eccentricity (e)** | Units: none | Range: 0 to 0.062499 | Default: 0 |
| **Argument of perigee (w)** | Units: semi-circles | Range: -1 to +1 semi-circle | Default:<br>0.972 222 222 222 222<br>(varies with **Satellite**) |
| **Mean anomaly (Mo)** | Units: semi-circles | Range: -1 to +1 semi-circle | Default:<br>-0.073 333 333 333 333 3<br>(varies with **Satellite**) |
| **Inclination (Io)** | Units: semi-circles | Range: -1 to +1 semi-circle | Default:<br>0.305 555 555 555 556<br>for all **Satellites** |
| **Longitude of ascending node (Weekly Epoch) (Wo)** | Units: semi-circles | Range: -1 to +1 semi-circle | Default:<br>0.537 777 777 777 778<br>(varies with **Satellite**) |
| ***Note**: The reference time for **Wo** is the weekly epoch at or before the orbit reference time and is referenced to the BeiDou start of week* | | | |
| **Mean motion difference (Delta N)** | Units: semi-circles per second | Range: -3.725 29 E-9 to +3.725 177 E-9 $semicircles.s^{-1}$ | Default: 0<br>for all **Satellites** |
| **Inclination rate (Idot)** | Units: semi-circles per second | Range: -9.313 227 8 E-10 to +9.312 088 9 E-10 $semicircles.s^{-1}$ | Default: 0<br>for all **Satellites** |
| ***Note**: When there is a large difference between **Reference Time** and the start of the scenario, use **Inclination rate** with caution. Extrapolation of the ephemeris over a long period could cause a significant change in inclination angle, so the resulting orbit is not typical of a BeiDou satellite.* | | | |
| **Right ascension rate (Wdot)** | Units: semi-circles per second | Range: -9.536 742 8 E-7 to +9.536 742 E-7 $semicircles.s^{-1}$ | Default: 0<br>for all **Satellites** |

#### 18.9.1.1 Buttons

***Note**: Currently, you can download TLE format files for the BeiDou constellation from:*
http://www.celestrak.com/NORAD/elements/beidou.txt.

*(To use this file in SimGEN, you must change its extension to *.tle)*

The buttons in the **Motion-Orbits** dialog are identical to those for GPS satellites, see **GPS-*Motion - Orbits*** (page 10-21).

This table details the current restrictions on saving and loading files:

| Action | Rinex | TLE | YUMA |
|---|---|---|---|
| Save orbits to file | ✘ | ✓ | ✓ |
| Load orbits from file | ✓ | ✓ | ✓ |


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When using BeiDou and Rinex files:

- Spirent treats the almanac reference time as BeiDou system time (SimGEN uses GPS time, so when the SimGEN constellation editor converts the Rinex file to orbital data, SimGEN converts BeiDou time to GPS time by adding 14 seconds).
- The reference time for **Wo** (Longitude of ascending node (Weekly Epoch)) is the weekly epoch at or before the orbit reference time and is referenced to the BeiDou start of week
- Spirent identifies BeiDou Rinex files using the file extension **.yyC* (where 'yy' refers to the last two digits of the year).

To identify use of BeiDou time in a BeiDou Rinex file, SimGEN uses all of the following conditions:

1) Column b) of the first line of the header of a BeiDou Rinex file contains BEIDOU. Notice SimGEN will also accept the text 'CMP' or 'COMPASS'. ***Example GPS Rinex file - version 2.10 format*** (page 10-28) details the Rinex header file.

2) The Rinex file extension must be **.yyC* (where yy are the last two digits of the year).

3) You are using the BeiDou constellation editor.

The following partial listing shows a BeiDou Rinex file header and the first two data lines:

```
2.10           C: BEIDOU NAV DATA                  RINEX VERSION / TYPE
SimGEN V5.03.00   Spirent       20-Aug-14 00:00   PGM / RUN BY / DATE
  4.6566D-09 1.4901D-08 -5.9605D-08 -5.9605D-08     ION ALPHA
  7.9872D+04 6.5536D+04 -6.5536D+04 -3.9322D+05     ION BETA
  0.000000000000D+00 0.000000000000D+00  507904   1806 DELTA-UTC: A0,A1,T,W
  16                             LEAP SECONDS
                                END OF HEADER
 1 14 8 20 0 0 0.0 0.000000000000D+00 0.000000000000D+00 0.000000000000D+00
  0.000000000000D+00 0.000000000000D+00 0.000000000000D+00-2.625403406770D+00
.
.
.
```

When using BeiDou and YUMA files, be aware that a YUMA file is only intended to give a reasonable indication of the position of the satellite in the sky. Loading a BeiDou YUMA file and running a scenario will correctly initialise the satellite orbits and give valid orbital motion. However, a YUMA file does not define all ephemeris parameters as it does not include data for mean motion difference or inclination rate, which will be set to zero.
Note that any existing perturbation definitions in the BeiDou constellation file are left unchanged.

## 18.9.2 Motion - Perturbations

***Notes**:*

***1)** Up to SimGEN version 4.05, SimGEN set to zero all values of **Motion-Perturbations** for GEO satellites (SVID 1 to 5). From version 4.05 onwards you can set non-zero values of **Motion-Perturbations** for GEO satellites.*

***2)** To ensure compatibility with scenarios created using SimGEN up to version 4.05, you must manually set to zero **Motion-Perturbations** for GEO satellites (SVID 1 to 5).*

This dialog is the same as **GPS-*Motion - Perturbations*** (page 10-34).

## 18.9.3 Motion - Track Errors

This dialog is the same as **GPS-*Motion - Track errors*** (page 10-35).

## 18.9.4 Motion - Clock errors

***Note**: Setting the **Delta Af0** clock divergence term is the same as applying a pseudorange error to that satellite.*

This dialog is the same as **GPS-*Motion - Clock errors*** (page 10-37), although parameter values may not be the same.

Currently, Spirent sets the initial value of IODC to zero as reference y) does not define an initial value for IODC.



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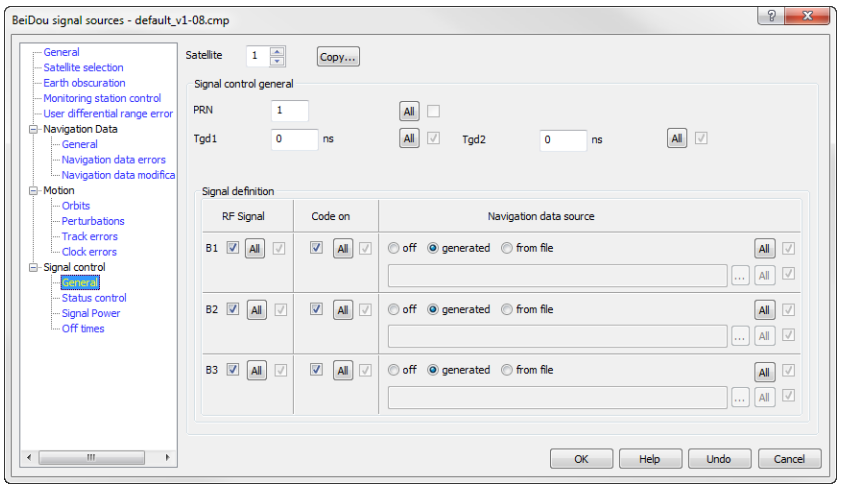
# 18.10 Signal control

Use the dialogs in the following sections to enter signal parameters for each BeiDou satellite.

## 18.10.1 Signal control - General

***Note**: Currently SimGEN does not apply Tgd to the pseudorange of satellites broadcasting on B3*

Use this dialog to specify characteristics of the BeiDou signal transmitted by each satellite:




| | | | |
|---|---|---|---|
| **Satellite** | Select the BeiDou satellite whose settings you want to change. This is the satellite SVID | | |
| **Signal control general** | | | |
| **PRN** | Set the PRN of **Satellite** | Range: 1 to 37 | |
| ***Note**: Spirent recommends you always set the satellite **PRN** to be identical to **Satellite** (the satellite SVID). The ability to change PRN is useful for special test purposes, such as testing two satellites with the same PRN.* | | | |
| **Tgd1** | Set the equipment group delay differential on B1I.<br>SimGEN applies the value of **Tgd1** you enter to the pseudorange of every satellite broadcasting on B1 | | |
| | Units: nanoseconds | Range: -51.2 to 51.14 ns | Default: 0 |
| ***Note**: Currently, setting non-zero values for Tgd1 will give invalid carrier and code pseudorange offsets* | | | |
| **Tgd2** | Set the equipment group delay differential of the B2\| signal.<br>SimGEN applies the value of **Tgd2** you enter to the pseudorange of every satellite broadcasting on B2 | | |
| | Units: nanoseconds | Range: -51.2 to 51.14 ns | Default: 0 |
| ***Note**: Currently, setting non-zero values for Tgd2 will give invalid carrier and code pseudorange offsets* | | | |
| **Signal definition** | Define the parameters for **B1**, **B2** and **B3** | | |
| **RF signal** | Select (default): RF signal on<br>Deselect: RF signal off<br><br>**All** (satellites) selected by default | | |
| **Code on** | Select (default): ranging code on<br>Deselect: ranging code off<br><br>**All** (satellites) selected by default | | |


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| | |
|---|---|
| **Navigation data source** | ***Navigation data*** details the Navigation data options<br><br>Choose from:<br>**generated** (default): SimGEN automatically generates the navigation data stream<br>**off**: (navigation data not broadcast)<br>**from file**: click **…** and select the navigation data file. The default location of these files is the current scenario folder. ***Navigation data source file format*** (page 18-18) details the file format.<br><br>Click **All** to use the same navigation data source ( **off**/**generated**/**from file**) for all **Satellites**<br>Click **All** (next to filename browse button) for all satellites to use the same navigation data file |

## 18.10.2 Navigation data

Reference aa) detail the format and content of the navigation data broadcast on B1 and B2. In SimGEN, you can choose from:

| Navigation data | Description |
|---|---|
| **From file** | Uses navigation data from a file you create.<br>***Navigation data source file format*** defines the format of this file, which also defines one of two data rates to use - 50 bps (default) or 500 bps.<br>Using this option, SimGEN will show files with extensions **.B1_nav* or **.B2_nav*. |
| **Generated** | ***Note**: **Generated** references all navigation data to GPS time.*<br><br>SimGEN automatically generates the navigation data stream.<br>Simulated BeiDou signals with generated navigation data allow accurate navigation as the BeiDou navigation data contains the appropriate ephemeris and clock information for the broadcasting satellite, along with valid almanac data (for up to 32 satellites), ionospheric and UTC information.<br>SimGEN sets NMCT data as unavailable.<br>SimGEN logs BeiDou navigation data to the current scenario folder using the files *BeiDou_Nav_Data.BD1* and *BeiDou_Nav_Data.BD2* for BeiDou D1 and D2 messages. Reference y) defines the content of these messages.<br>You can use the ***BeiDou Nav Data Extract utility*** (page 26-58) utility to decode the navigation data file. |
| **Off** | Does not apply navigation data to the RF signal |

### 18.10.2.1 Navigation data source file format

***Notes**:*


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***1)*** *These files are not part of the scenario, since they are not present in the* ***Scenario Contents*** *window. These files will not transfer if you copy the scenario using SimGEN*

***2)*** *<CR> and<LF> characters must terminate each line of the navigation data source file*

***3)*** *You must use the same bit rate for B1, B2 and B3 frequencies*

***4)*** *The navigation data source file format uses BeiDou time, which lags GPS time by 14 seconds, for example: 23:58:00 (BeiDou time) is 23:58:14 (GPS time)*

All BeiDou navigation data files you create must have the following format, which shows a 50 bps example with four lines of data:

```
!Example file - lines starting with ! are comments
!There are two header fields required, BIT_RATE and START_TIME
!BIT_RATE must be specified as either 50 or 500 (bits per second)
!START_TIME is date and time in BEIDOU time. It defines the time of applicability
!of the first nav data bit in the file.
!Sets of nav data bits then follow, as lines of hex characters, each character
!representing 4 bits. Each line must contain 6 seconds of data, so 75 characters
!(300 bits) for 50 bps rate,or 750 characters (3000 bits) for 500 bps rate.
!All lines must be terminated by CR (carriage return) and LF (line feed) characters.
!Example data follows:
BIT_RATE 50
START_TIME "29-FEB-2012 02:59:54"
E241158680760B28010819820042E5108011BC042007680108198200 42E5108011BC0420076
E24155BA8076A90422040C509090262424250D090902624242 50D090902624242 50D0909026
E240559E80288A00199EA3D948006A80616CB77D98FA43B3757D821445AFFF875E31B0E817D
E2409596807B7360DCBCE1AEB122F760A8606E33156581066015E276F832411959E345829D6
.
.
.
```

You must keep the order of entries (other than comment lines) as shown in the example above. This table defines the entries:

| Entry | Comment |
|---|---|
| ! | Denotes a comment line. |
| BIT_RATE | (mandatory) Denotes the bit rate of the file in bits (or symbols) per second<br>Use 50 bps or 500 bps |
| START_TIME “dd-mmm-yyyy hh:mm:ss” | (mandatory) Denotes the BeiDou time corresponding to the first message element in the file.<br>Must always be assigned<br>Must correspond with a message epoch<br>Must be enclosed in inverted commas<br>Must follow BIT_RATE |
| <navigation data message> | Must contain 75 hex characters per line for 50 bps; or 750 hex characters for 500 bps.<br>Each hex character defines four bits of data, for example, “A” defines the sequence 1010. |

SimGEN applies the list of messages sequentially. If the scenario start time corresponds exactly with the start time of the message list, SimGEN applies the first message in the list when the run starts; otherwise, SimGEN determines the appropriate starting point in the list according to the relative time difference and duration of each message. When SimGEN reaches the end of the message list, it continues the sequence from the first message in the list. Normally, you would set the scenario start time to the same time as the file start time (after conversion to GPS time) if this is on a GPS epoch, or else to the next GPS epoch following the start time.

The following example shows a 500 bps file with the first line of data (in this example, the 750 characters are wrapped to fit the page width. In a 500 bps file, the data occupy one line):

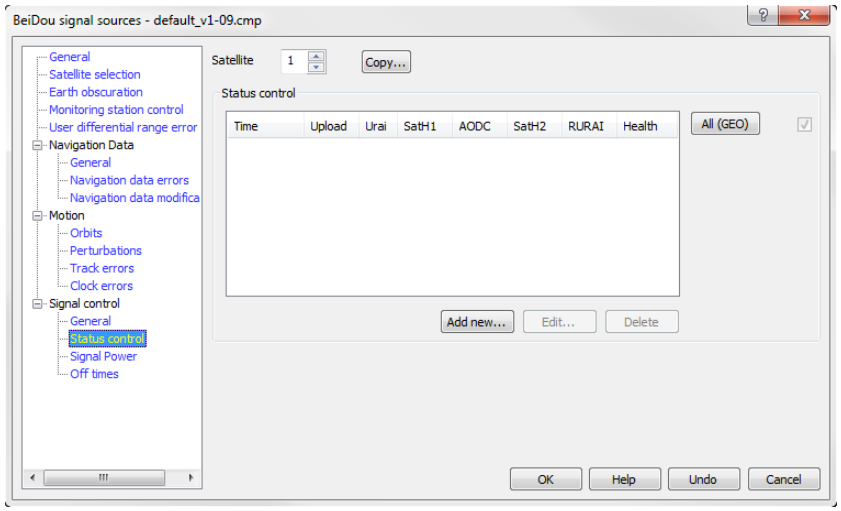
```
!Example file - lines starting with ! are comments
!There are two header fields required, BIT_RATE and START_TIME
!BIT_RATE must be specified as either 50 or 500 (bits per second)
!START_TIME is date and time in BEIDOU time. It defines the time of applicability
```


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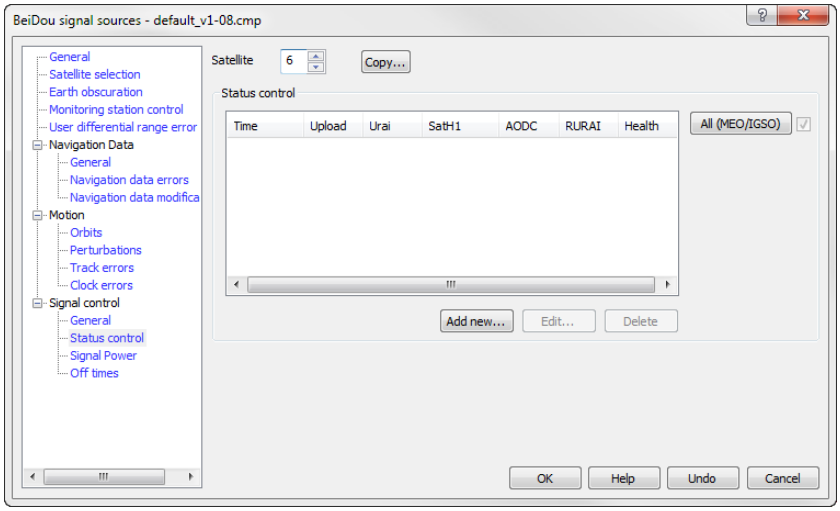
```
!of the first nav data bit in the file.
!Sets of nav data bits then follow, as lines of hex characters, each character
!representing 4 bits. Each line must contain 6 seconds of data, so 75 characters
!(300 bits) for 50 bps rate,or 750 characters (3000 bits) for 500 bps rate.
!All lines must be terminated by CR (carriage return) and LF (line feed) characters.
!Example data follows:
BIT_RATE 500
START_TIME "29-FEB-2012 02:59:54"
E240559D2A2000000000000110500008EEC0001999000066640001999000066640001999000010101010101
1010101010101010101010101010101010101010101010101010101010101010101010101010101010101010
1010101010101010101010101010101010101010101010101010101010101010101010101010101010101010
1010101010101010101010101010101010101010101010101010101010101010101010101010101010101010
1010101010101010101010101010101010101010101010101010101010101010101010101010101010101010
1010101010101010101010101010101010101E240559C2E80000A8080000C610000EC440001999000066640
0019990000666400019990000101010101010101010101010101010101010101010101010101010101010101
1010101010101011010101010101010101010101010101010101010101010101010101010101010101010101
1010110101010101010101010101010101010101010101010101010101010101010101010101010101010110101
0101010101010101010101010101010101010101010101010101010101010101010101010101010101010101
.
.
.
```

## 18.10.3 Signal control - Status control

Use this dialog to edit or create status control data, which depends on satellite type (GEO or MEO / IGSO). This figure shows the default settings for GEO satellites (satellites 1 to 5):




This figure shows the default settings for MEO / IGSO satellites (satellites 6 to 30):




Click **All (GEO)** or **All (MEO/IGSO)** to set the status control of all satellites to that of the current satellite (selected by default for MEO satellites, deselected by default for MEO / IGSO satellites).


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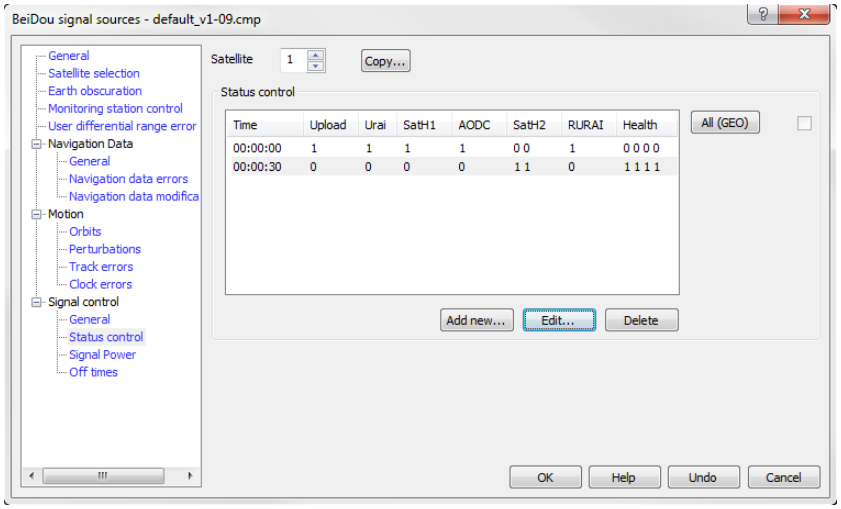
To add a new status control line see ***Add a new status control***, then click **Add new…**

To edit an existing line in the status control area, highlight the line and click **Edit…**

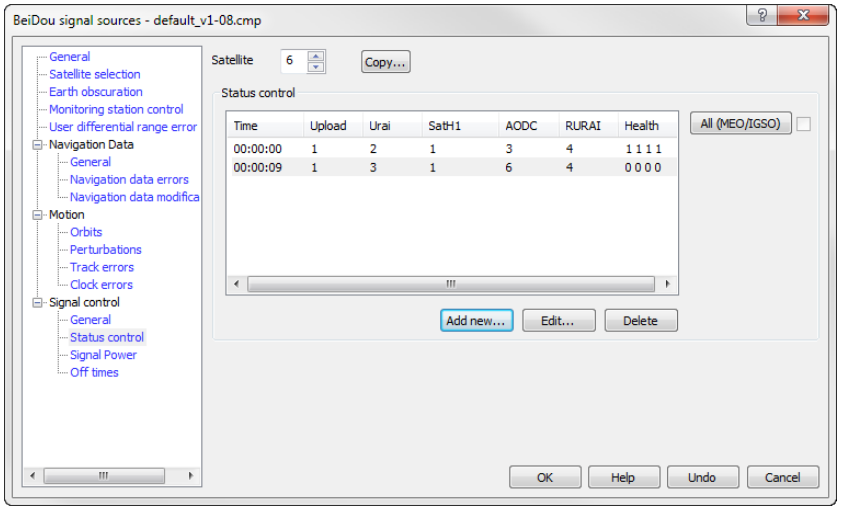
To delete an existing line in the status control area, highlight the line and click **Delete**

Click **Copy** to copy details from one GEO satellite to all GEO satellites, or from one MEO / IGOS satellite to all MEO / IGSO satellites.

This figure shows example status controls for GEO satellites:



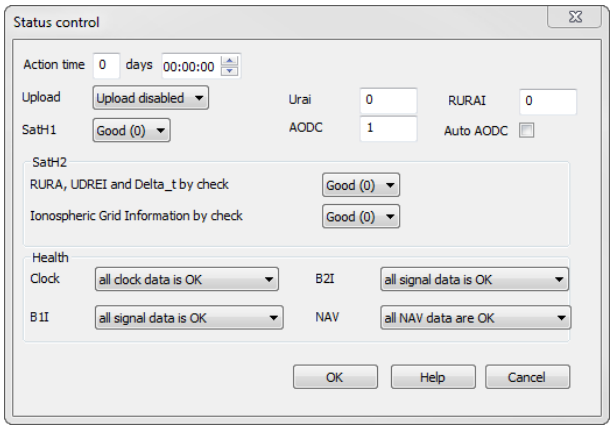

This figure shows example status controls for MEO / IGSO satellites:



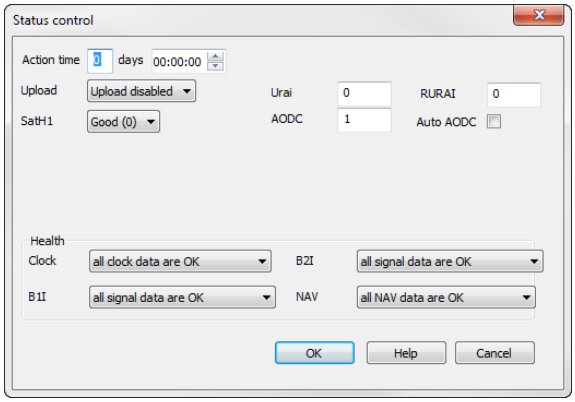
### 18.10.3.1 Add a new status control

Clicking **Status Control-Add new…** opens a dialog that depends on the satellite type:

**GEO satellites (satellites 1 to 5)**




**MEO / IGSO satellites (satellites 6 to 30)**



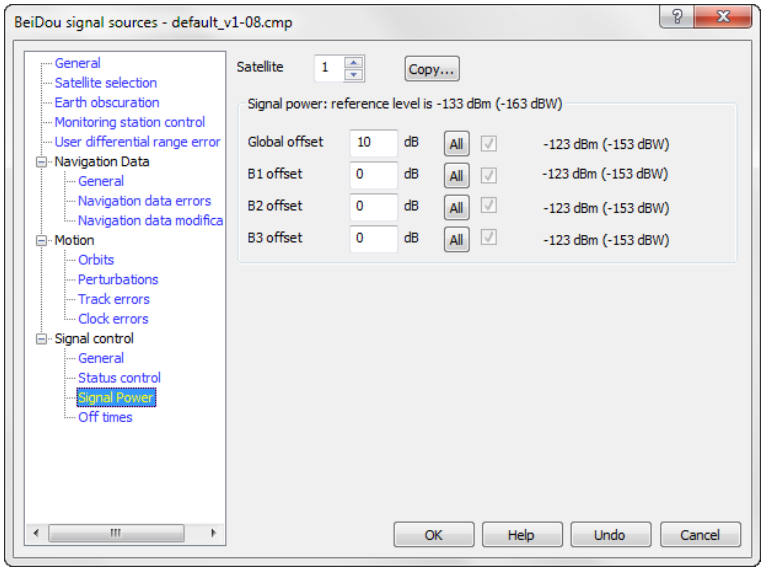

| | | | |
|---|---|---|---|
| **Action time** | The time into the scenario you want to send the new status | | |
| | Units:<br>d hh:mm:ss | Range:<br>0 days 00:00:00<br>to 23 days 23:59:59 | Default:<br>0 days 00:00:00 |
| **Upload** | Uploads almanac and / or ephemeris data at the next, or current, Frame epoch. | | |
| | Choose from:<br>**Upload disabled** (default)<br>**Upload enabled** | | |
| **urai** | Type the new value of the user range accuracy index you want to use | | |
| | Units: none | Range: 0 to 15 | Default: 0 |
| **RURAI** | Type the new value of the Regional User Range Accuracy Index you want to use | | |
| | Units: none | Range: 0 to 15 | Default: 0 |
| **SatH1** | Select autonomous satellite health parameter | | |
| | Choose from:<br>**Good(0)** (default)<br>**Bad(1)** | | |
| **AODC** | Set the initial age of data clock | | |
| | Units: none | Range: 0 to 31 | Default: 1 |


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| | |
|---|---|
| **Auto AODC** | SimGEN calculates AODC starting with a default value of **AODC** of 1 |
| | **Disabled** (default): SimGEN uses the value you type in **AODC** and applies it at the **Action time** you specify<br>**Enabled**: SimGEN assigns an initial value of **1** for **AODC** and proceeds with AODC calculation |
| **SatH2**<br>(GEO Satellites only) | Select the received up-link regional user range accuracy (**RURA**), user differential range error (**UDRE**) and equivalent clock correction (**Delta_t**)<br>This is the MSB of the flag<br>Select the received up-link ionospheric grid information<br>This is the LSB of the flag |
| **RURA, UDREI and Delta_t by check** | Choose from:<br>**Good(0)** (default)<br>**Bad(1)** |
| **Ionospheric Grid Information by check** | Choose from:<br>**Good(0)** (default)<br>**Bad(1)** |
| **Health** | Set the health status of the S-band and L5 navigation data |
| **Clock** | Choose from:<br>**all clock data is OK** (default)<br>**some or all clock data are bad** |
| **B2I** | Choose from:<br>**all signal data is OK** (default)<br>**some or all signal data are bad** |
| **B1I** | Choose from:<br>**all signal data is OK** (default)<br>**some or all signal data are bad** |
| **NAV** | Choose from:<br>**all NAV data are OK** (default)<br>**some or all NAV data are bad** |

## 18.10.4 Signal control - Signal power

Use this dialog to control the signal level characteristics of all simulated carrier frequencies at the RF output of the signal generator.





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If you select **BeiDou-signal sources file-*General*-Signal Strength-Modelled** (page 18-3), SimGEN applies the values you enter in this dialog before performing modelling.

| | | | |
|---|---|---|---|
| **Satellite** | Select the **Satellite** whose settings you want to change | | |
| **Signal power** | ***Note**: For all signals, the power level SimGEN applies is shown to the right of **All***<br><br>Set the signal power offsets from the BeiDou reference level of -133 dBm | | |
| **Global offset** | Type the Global offset with respect to the reference level | | |
| | Units: decibels | Range: -20.0 to +20.0 dB | Default: 10 |
| **B1 offset**, **B2 offset** and **B3 offset** | Type the relative power offset for each signal **B1**, **B2** and **B3** | | |
| | Units: decibels | Range: -20.0 to +20.0 dB | Default: 0 |

Click **All** to apply that power level offset to all BeiDou satellites.

## 18.11 Signal control - Off times

This dialog is the same as **GPS-*Signal Control - Off times*** (page 10-50).

## 18.12 PRN codes

***Notes**:*

***1)** The signal generator does not permanently store these PRN codes. They are lost when you turn off ac power to the signal generator*

***2)** You must save the PRN file with the filename, and in the location, this section defines.*

***3)** Spirent provides example PRN files with appropriate test codes.*

To assign a PRN to a satellite, open ***Motion - Orbits*** (page 18-13) and type the PRN for the satellite in **PRN**. You can assign a different PRN for each satellite (by typing the PRN for each satellite SVID); however, Spirent recommends you always use the default setting of SVID and PRN being identical.

SimGEN generates BeiDou B1 ranging codes from the sum of two-bit sequences (G1/G2) that are derived from two 11-bit linear shift registers. Different output tapping points for G2 are used in order to obtain different phase shifts for each satellite. The resulting ranging codes are broadcast at 2.046Mcps and have a length of 2 046 chips.

SimGEN reads the pre-generated PRN code sequences (separately for each frequency) from files that must use these filenames:

| Signal | Filename |
|---|---|
| B1 | *BeiDou_prns_B1.dat* |
| B2 | *BeiDou_prns_B2.dat* |
| B3 | *BeiDou_prns_B3.dat* |

These files must be located in the folder:
*C:\Program Files\Spirent Communications\Positioning Application\BeiDou_data_sets*

and must use the filename format and capitalising shown in the table above.

### 18.12.1 PRN code file format

Each PRN file contains one primary and one secondary sub-set of PRN data for each satellite in the BeiDou constellation.

This example listing shows a typical format for the PRN definition file for the B1 signal:

```
BPID 01
```


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```
BPLO 01 B1_IP 2046 123456789ABCDEF01234567890123456........3456789012
BPLO 01 B1_IS 20 FB2B1
BPLO 02 B1_IP 2046 123456789ABCDEF01234567890123456........3456789012
BPLO 02 B1_IS 20 FB2B1
BPLO 03 B1_IP 2046 123456789ABCDEF01234567890123456........3456789012
BPLO 03 B1_IS 20 FB2B1
……  data for satellite
……  ranging code numbers 4 to 36
BPLO 37 B1_IP 2046 123456789ABCDEF01234567890123456........3456789012
BPLO 37 B1_IS 20 FB2B1
```

After the BPID identifier, the subsequent lines in the file define the primary and secondary (optional) codes for each satellite, using the following syntax:

```
BPLO <nn> <code type> <code length> <data bits>
```

Where:

| Parameter | Description |
|---|---|
| `BPID <nn>` | Defines the identification code for the data set, range: 1 to 16.<br>It identifies when a new set of PRN data is to be loaded.<br>Currently, there is only one file so of limited use. |
| `BPLO <nn>` | Satellite PRN number (ranging code number) |
| `code type` one of: | |
| `B1_IP` | Primary code on B1 |
| `B1_IS` | (optional) Secondary code on B1 |
| `B2_IP` | Primary code on B2 |
| `B2_IS` | (optional) Secondary code on B2 |
| `B3_IP` | Primary code on B3 |
| `B3_IS` | (optional) Secondary code on B3 |
| `code length` | An integer number giving the number of chips in the sequence |
| `data bits` | Lists the PRN sequence as a series of hexadecimal characters, each defining four chips. For example, “A” defines the sequence 1010<br>The total number of characters must be sufficient to accommodate the required code length. If necessary, you must pad the last hexadecimal value with trailing zeroes. |


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# 19 Ground Transmitter (embedded interferer)

***Notes**:*

***1)** L1 Ground Transmitter (L1GTx) is only available with the GSS7700 and GSS 8000-series GPS dual-output signal generators. The GSS8000-series product datasheet gives more details on support for L1GTx - see reference nn)*

***2)** L2 Ground Transmitter (L2GTx) is only available with the appropriate GSS8000-series signal generator. The GSS8000-series product datasheet gives more details on support for L2GTx - see reference nn).*

***3)** For complex interference sources, the GSS7765 ISS system uses one or more external signal generators to provide complex modulation types and a higher interferer to signal ratio. Contact Spirent for details.*

***4)** Depending on the channel availability in your signal generator, SimGEN can use up to sixteen separate Ground Transmitters.*

Ground Transmitter lets you simulate a GPS or GLONASS constellation and a constellation of up to 16 Interference (Ground Transmitter) sources.

SimGEN version 2-60 onwards supports GPS L1 Ground Transmitters.

SimGEN version 2-82 onwards also supports GPS L2 Ground Transmitters.

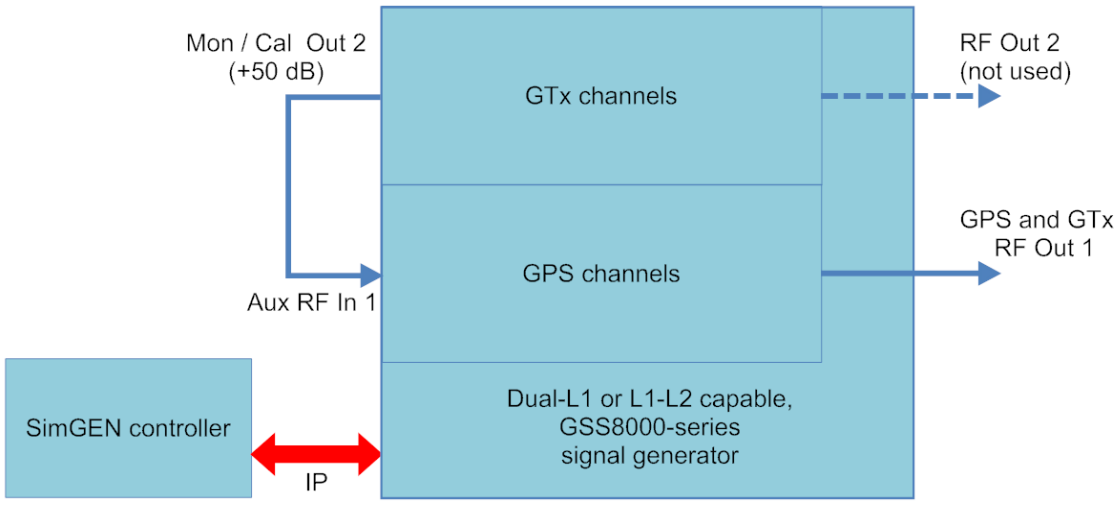
SimGEN version 3-00 onwards lets you create and use separate antenna patterns for each Ground Transmitter in your scenario. SimGEN version 3-00 onwards supports up to 16, separate, Ground Transmitter antenna patterns. By default, SimGEN uses the same antenna pattern file for every Ground Transmitter antenna. To use separate antenna patterns, see ***Receive and transmit antennas*** (page 23-1), then create an antenna selection file and the appropriate level pattern files.

SimGEN version 4-00 onwards supports (as separately licenced features) higher power and additional modulation types, see ***Signal control (licenced features)*** (page 19-11).

SimGEN version 5.04 onwards supports GLONASS Ground Transmitters and (as a separate licence) user motion for Ground Transmitters

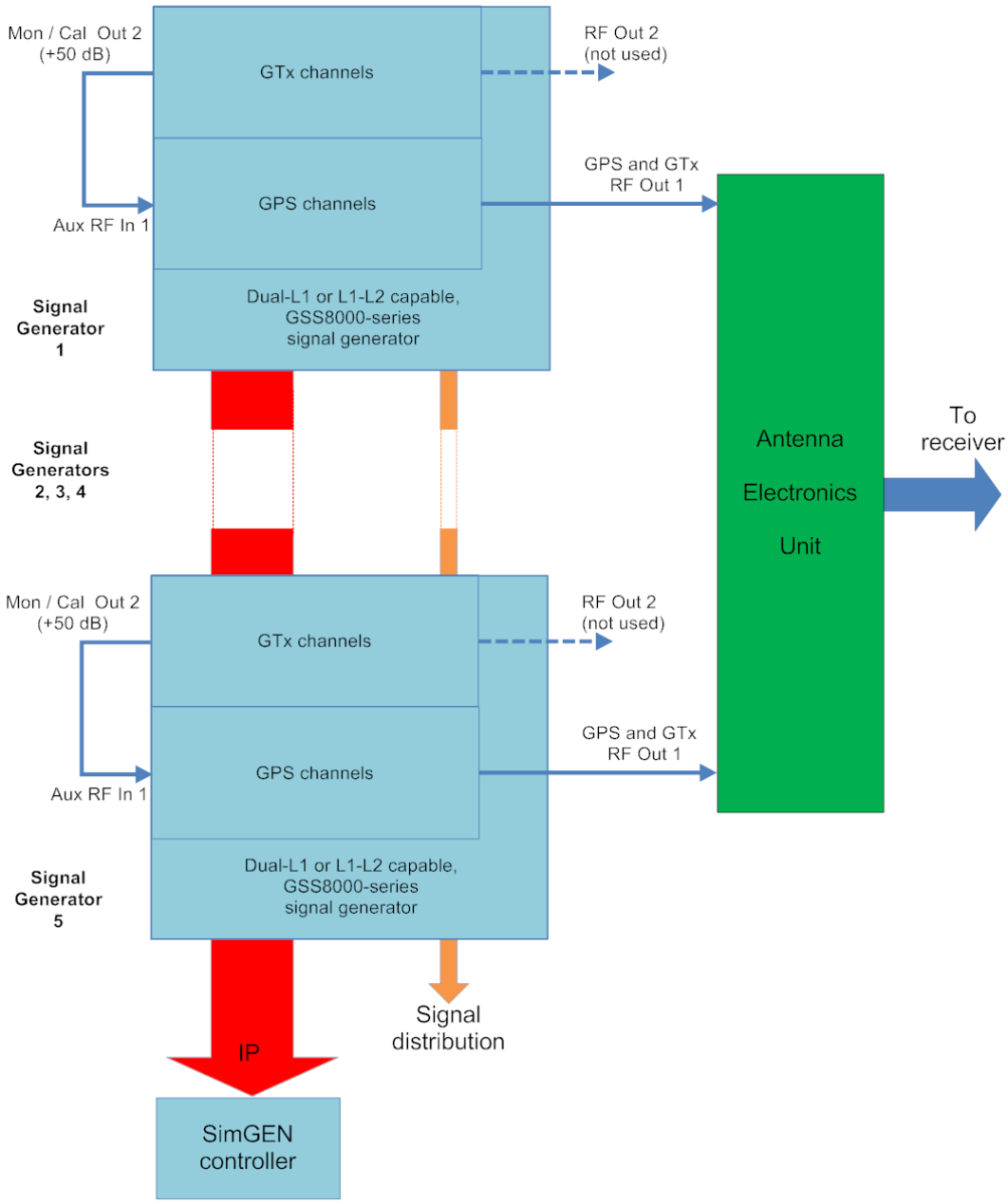
This document and SimGEN dialogs also refer to Ground Transmitter as GTx.

Ground Transmitter in a GSS8000-series signal generator uses the 50 dB difference between the signal at the signal generator's rear-panel Mon/Cal port and the signal at the front panel RF Out port to provide a high-level interferer signal. The schematic below shows the Ground Transmitter signal, at the rear-panel Mon/Cal Out 2 port, connected to the Aux RF In 1 port. The front panel RF Out 1 port provides the combined GNSS and GTx signal. This figure shows the arrangement for a GSS8000-series signal generator supporting GPS Ground Transmitters:




You can use Ground Transmitter with multiple GSS8000-series (or the superseded GSS7700), dual-L1, or L1-L2 capable, signal generators. The following figure shows a configuration of five signal generators, building on the simple configuration in the previous figure. Typically, CRPA testing uses this type of configuration as it takes full advantage of the coherent nature of the interference sources relative to the GNSS signal. Contact Spirent for details on using Ground Transmitter in a complex configuration.


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## 19.1 Configuring the Ground Transmitter

***Notes**:*

***1)** You must connect the signal generator's Mon Cal Out 2 port to the Aux RF In 1 port using the semi-rigid coaxial cable assembly Spirent provides in the simulator accessories pack.*

***2)** You can change the signal level by inserting a suitable attenuator or amplifier in the co-axial link between the Mon/Cal port and the Aux RF In port.*
*Spirent does not supply attenuators or amplifiers.*

***3)** In all Ground Transmitter dialogs:*

*Click **All** to copy data to all Ground Transmitters.*

*Click **Copy** to copy data to the Ground Transmitters you select in the **Copy** dialog.*

By default, SimGEN uses the distance from the Ground Transmitter to the vehicle you are modelling to determine the power level. Alternatively, you can apply a fixed receive power level, which does not change with vehicle motion, see ***General*** (page 19-5).

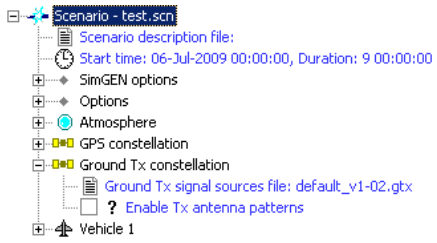
You can choose to apply CW or broadband PSK modulation to the interfering signal, see ***Signal control - General*** (page 19-8).


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Use the constellation editor to edit data in the Ground Transmitter constellation file. The editor shows the data in the Ground Transmitter constellation file as a series of “pages”. The left-hand area shows the pages you can select for editing; the right-hand area shows the details of the page you selected in the left-hand area. This section describes how you select and change details in the right-hand area.

SimGEN checks the range of the value you type in a text box and, if incorrect, displays the range of acceptable values.

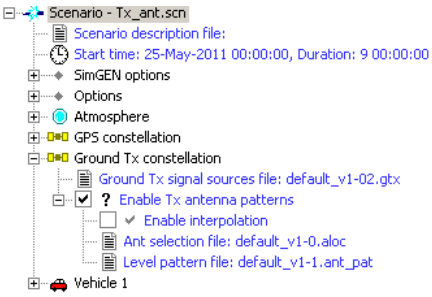
After associating the Ground Transmitter signal type with an antenna, the Ground Transmitter constellation file appears in the **Scenario contents** window, it is labelled ‘Ground Tx’:




Edit the Ground Transmitter constellation file in the same way as you would edit a GNSS constellation file.

***Transmitter antenna level and phase*** patterns (page 23-20) details creating and applying **Tx antenna patterns**.

The following figure shows the **Scenario contents** window of a Ground Transmitter using Transmit antenna patterns:




Be aware that, in the Earth-based Ground Transmitter, the +90° elevation of the antenna pattern points towards the Earth.

To set up a Ground Transmitter, follow these steps, in the order shown:

- → Follow ***Signal generator configuration*** and set SimGEN to use the correct signal generator configuration
- → Follow ***Assign an antenna*** (page 19-4) and assign the Ground Transmitter constellation to a vehicle antenna
- → Follow ***General*** (page 19-5) onwards to configure the Ground Transmitter constellation

### 19.1.1 Signal generator configuration

***Note****: If you took delivery of a GSS7700 L1/L2 signal generator before October 2006, contact Spirent to obtain an appropriate hardware configuration.*

First, open the menu item **Options-*Hardware Configuration*** (page 5-18) and change your hardware configuration to support **Ground Transmitter**.

Then follow ***Assign an antenna*** and assign the Ground Transmitter constellation to an antenna on your vehicle.

### 19.1.2 User motion

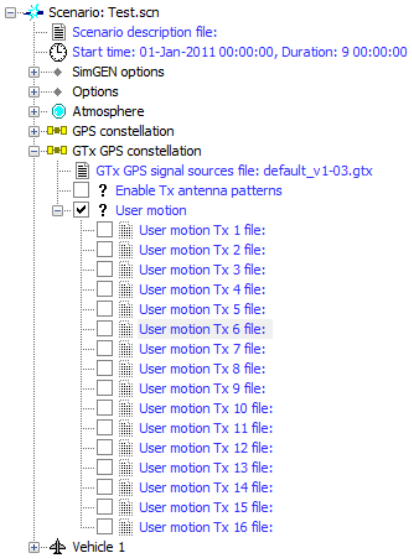
***Licenced feature****: You will need a separate licence to use* ***user motion****. Contact Spirent for licencing details.*

GPS and GLONASS Ground Transmitters support user motion.

Ground Transmitter user motion lets you use separate user motion (**.umt*) files to apply individual motion to each Ground Transmitter. **Vehicle models-*User motion files*** (page 21-38) describes the use and format of user motion


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(**.umt*) files. Each user motion file is directly associated with the Ground Transmitter constellation file. Select **user motion** to expand the dialog:




Select the Ground Transmitter to which you want to apply motion (a tick appears in the checkbox), then double-click to open the **User motion file selection** dialog and select the file you want to use.
Repeat for each Ground Transmitter to which you want to apply motion.

You can also control Ground Transmitter user motion using the SimREMOTE MOT command - see reference qq).

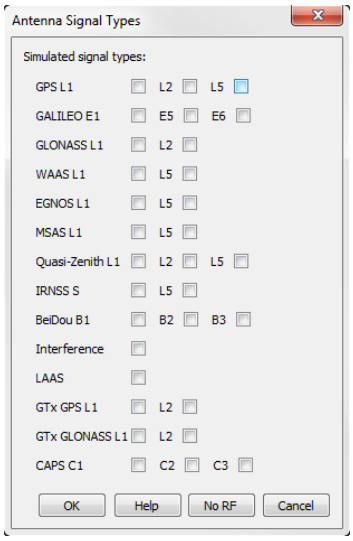
### 19.1.3 Assign an antenna

Working in the **Scenario Contents** window, assign the Ground Transmitter constellation to an antenna:

→ Expand **Vehicle 1**

→ Expand **Antenna 1**

→ Double-click **Signal types** to open the **Antenna Signal Types** dialog:




→ Select the GPS signal type(s) from **GPS L1**, **GPS L2** or **GPS L5**; or the GLONASS signal type(s) from **L1** or **L2**

→ Select **GTx GPS L1** and/or **Ground Tx L2**; or **GTx GLONASS L1** and/or **L2**

→ Click **OK**

Repeat these steps for each antenna on the vehicle.

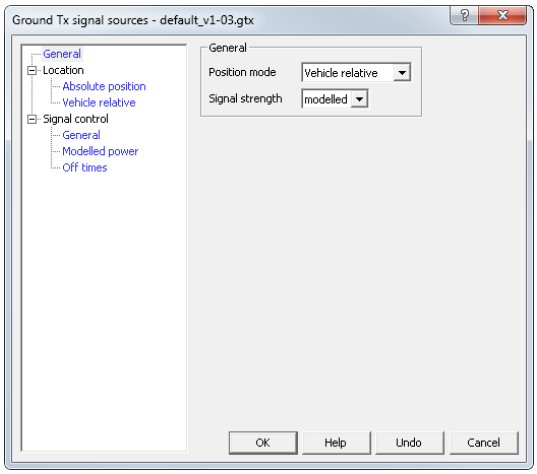

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## 19.2 General

Use the **Ground Tx signal sources file-General** dialog to configure the Ground Transmitter constellation:

→ In the **Scenario Contents** window, expand **Ground Tx constellation**

→ Double-click **Ground Tx signal sources file** to open the **General** dialog:



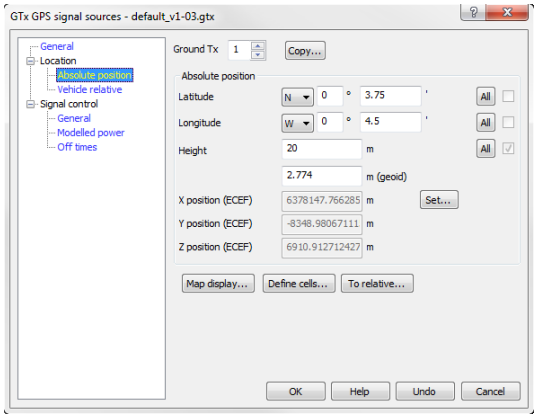

| | |
|---|---|
| **Position mode** | Choose from: |
| **Vehicle relative** | (default) defines the position of each Ground Transmitter as an initial distance from the vehicle's CofG. |
| **Absolute position** | Defines the position of each Ground Transmitter using **latitude**, **longitude** and **height** |
| **Signal Strength** | Choose the type of power level control from: |
| **modelled** | (default) Uses modelled power level control to vary the received signal-levels as the distance between the vehicle and the Ground Transmitter<br>Disables ***Signal control - General*-Fixed L1 power** (page 19-8) |
| **fixed** | Uses a fixed power level to fix the received signal level, regardless of vehicle motion<br>Enables ***Signal control - General*-Fixed L1 power** |

## 19.3 Location

Set the location of each Ground Transmitter using either ***Absolute position*** or ***Vehicle relative*** (page 19-7).

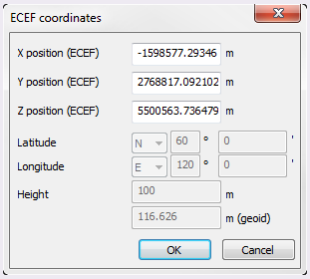
### 19.3.1 Absolute position

Set the absolute position of each Ground Transmitter by entering either **Latitude**, **Longitude** and **Height** , or ECEF coordinates, using this dialog:

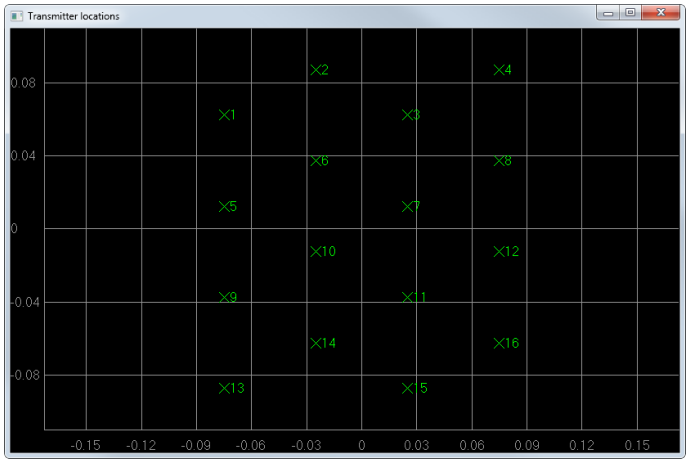




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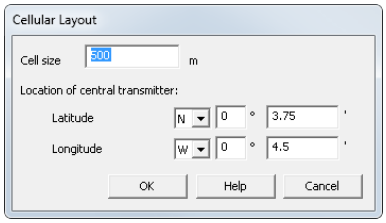
| | | | |
|---|---|---|---|
| **Ground Tx** | Select the Ground Transmitter whose position you want to set | | |
| **Absolute position** | Enter the absolute position of the **Ground Transmitter** | | |
| **Latitude** | Type the position of the **Ground Tx** | | |
| | Units: degrees, minutes | Range: N 90° 0.0′ to S 90° 0.0′ | |
| **Longitude** | Type the position of the **Ground Tx** | | |
| | Units: degrees, minutes | Range: W 180° 0.0′ to E 180° 0.0′ | |
| **Height** | Type the height of the **Ground Tx** | | |
| | Units: metres | Range: 0<br>to 100 000 m | Default: 0<br>(-17 geoid) |
| Clicking **Set…** opens this dialog in which you can enter the reference location in **ECEF coordinates**:<br>  <br><br>Notice **Latitude**, **Longitude** and **Height** update automatically as you move between the X, Y and Z positions. | | | |
| **X position (ECEF)**,<br>**Y position (ECEF)**,<br>**Z position (ECEF)** | Units: metres | Range: -1E10 to 1E10 m | |

Click **Map display** to show the position of all Ground Transmitters on a map:




This map display uses the same zoom commands as **Main display windows-*Ground Track*** (page 3-12).

Click **Define cells** to open the **Cellular Layout** dialog, see below. Set the position of each Ground Transmitter around a central Ground Transmitter (SimGEN uses Ground Transmitter number 11 as the central transmitter). You must set the location of the central transmitter using its latitude and longitude. You must use the same cell size for all Ground Transmitters in the scenario.

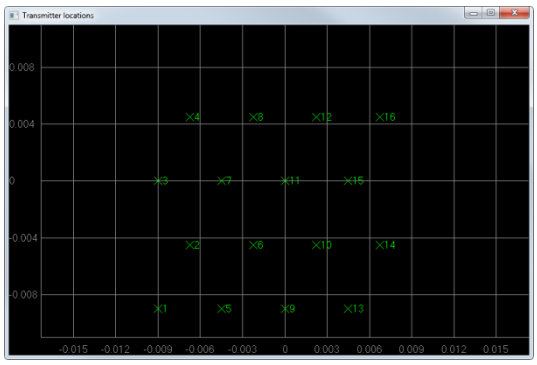




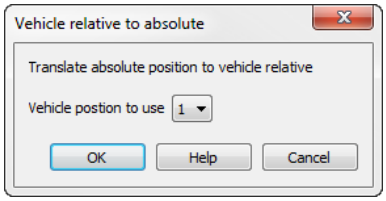
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| | | | |
|---|---|---|---|
| **Cell size** | Type the distance between each Ground Transmitter | | |
| | Units: metres | Range: 20 to 10 000 m | Default: 500 |
| **Latitude** | Type the position of the central transmitter (number 11) | | |
| | Units: degrees, minutes | Range: N 90° 0.0´ to S 90° 0.0´ | |
| **Longitude** | Type the position of the central transmitter (number 11) | | |
| | Units: degrees, minutes | Range: W 180° 0.0´ to E 180° 0.0´ | |

This figure shows the **Map display...** for Ground Transmitters around Ground Transmitter 11, (position set to 0°W, 0°N) using the default **Cell size**.



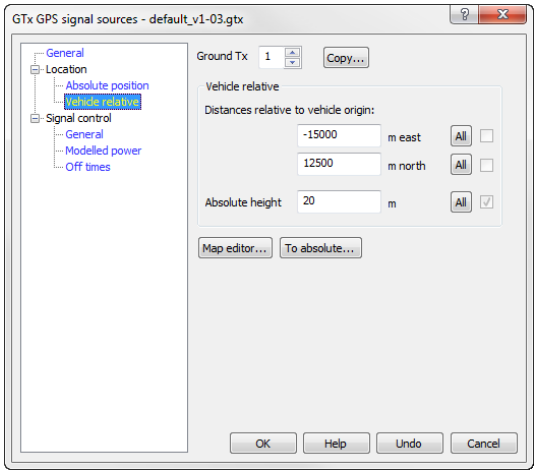

Click **To relative…** then select the **Vehicle position to use** to use the location of this vehicle to calculate the RELATIVE offset of each Ground Transmitter from their absolute position.




## 19.3.2 Vehicle relative

***Note**: **Ground Transmitter** does not reference height to the vehicle CofG.*

Set each Ground Transmitter a fixed distance from the vehicle CofG using this dialog:

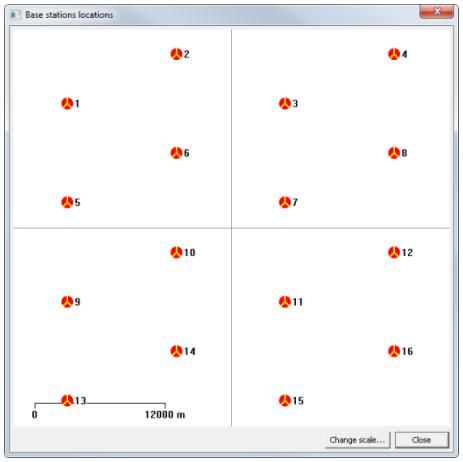



| | |
|---|---|
| **Ground Tx** | Select the Ground Transmitter whose position you want to set |
| **Vehicle relative** | Enter the distance of the Ground Transmitter relative to the vehicle origin |


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| | | | |
|---|---|---|---|
| **Distances relative to vehicle origin m east, m north** | Type the distances from the Ground Transmitter to the vehicle CofG | | |
| | Units: metres | Range:<br>± 10 000 000 m | Default:<br>-15 000 (east),<br>12 500 (north) |
| **Absolute height** | Type the **Absolute height** of the Ground Transmitter | | |
| | Units: metres | Range: -10 000 to +1 000 000 m | Default: 20 |

Alternatively, click **Map Editor** to display a map with one icon representing each Ground Transmitter, see the following figure.

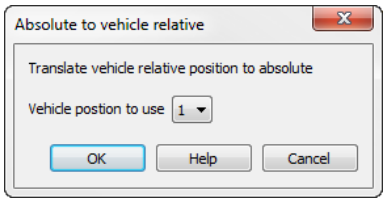



The map opens at a suitable scale, shown in the bottom left-hand corner, to show all Ground Transmitter icons. You can change the zoom level by using the same zoom commands as **Main display windows-*Ground Track*** (page 3-12), or:

| | | | |
|---|---|---|---|
| Clicking on **Change scale** or right-clicking in map | Opens the **Map properties** dialog, type a value for **Map size** | | |
| **Map size** | Units: metres | Range: 1 000 to 1 000 000 m | Default: 40 000 |

You can drag and drop each Ground Transmitter icon to a new position. The cursor changes to a cross-hair when you place it over a Ground Transmitter icon; after clicking on an icon, figures in brackets show the (x,y) position of the Ground Transmitter relative to the vehicle (at the centre of the map).

Click **To absolute…** then select the **Vehicle position to use** to use the location of this vehicle to calculate the ABSOLUTE position of each Ground Transmitter from their current RELATIVE locations from this vehicle.



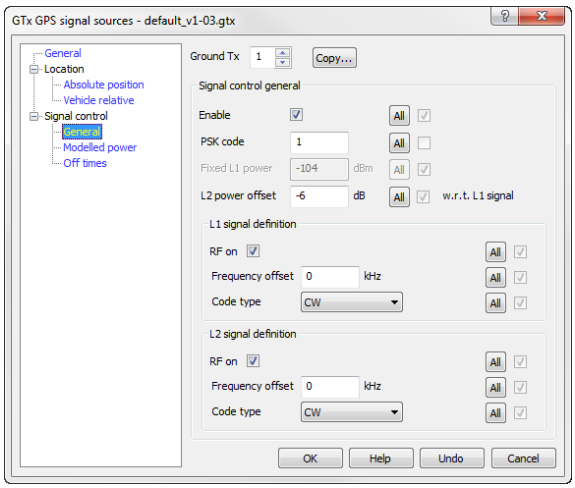

## 19.4 Signal control (standard features)

Use the following sections to set the signal parameters for each Ground Transmitter. Standard features do not require a separate licence.

### 19.4.1 Signal control - General

Set general signal parameters for each Ground Transmitter using this dialog:


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| | | | |
|---|---|---|---|
| **Ground Tx** | Select the Ground Transmitter whose signals you want to define | | |
| **Signal control general** | | | |
| **Enable** | Select (default): Enable the **Ground Tx** (**Enable - All** selected by default)<br>Deselect: Disable the **Ground Tx** | | |
| **PSK code** | Type the PSK sequence for the **Ground Tx** | | |
| | Units: none | Range: 1 to 16 | Default: same as **Ground Tx** |
| ***Note**: You can use a different PRN sequence (**PSK code**) with each Ground Transmitter* | | | |
| **Fixed L1 power** | (disabled if you use ***General***-signal strength-modelled (page 19-5))<br>Set the incident power level at the receiver antenna if you use ***General*-signal strength-fixed** | | |
| | Units: dBm | Range: -138.8 to -69 dBm | Default: -104 |
| **L2 power offset** | Set the L2 power offset from L1 | | |
| | Units: dB | Range: -10 to 10 dB | Default: -6 |
| **L1 signal definition**<br>**L2 signal definition** | Select the signal options for **L1** and **L2** | | |
| **RF on** | Select (default): RF on<br>Deselect: RF off | | |
| **Frequency offset** | Units kiloHertz | Range:<br>± 600 kHz (to nearest 10 kHz) | Default: 0 |
| **Code type** | Choose from: | | |
| **CW** | (default) | | |
| **PSK broadband** | Uses a (sin x)/x spectral distribution<br>20.46 MHz main lobe width<br>Approximates wide-band noise, derived from the GPS L5 PRN sequence | | |
| **PSK narrowband** | Uses a (sin x)/x spectral distribution<br>102.3 kHz main lobe width.<br>Approximates narrow-band noise, derived from the GPS L5 PRN sequence | | |

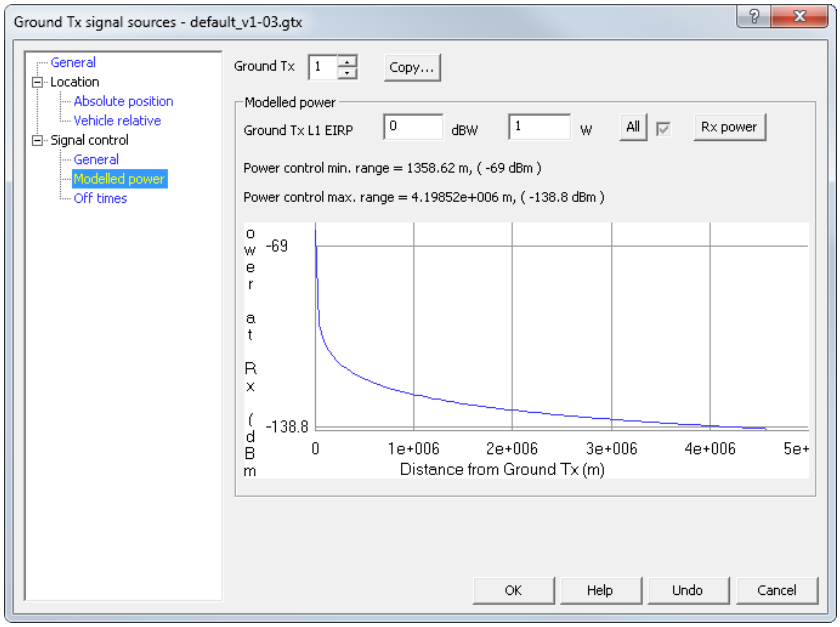
## 19.4.2 Signal control - Modelled Power

***Note**: When the signal generator cannot provide the receiver power level you want, the power level limits at the signal generator maximum.*


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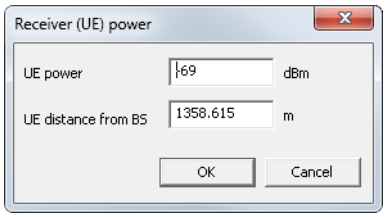
If you selected ***General*-Signal strength-modelled** (page 19-5), SimGEN configures the modelled power for each Ground Transmitter.

The dynamic power range of each Ground Transmitter is set at 46 dB (standard feature range: -20 to +26 dB). You can determine the distance over which the receiver antenna experiences a change in power-level using this dialog:




| | | | |
|---|---|---|---|
| **Ground Tx** | Select the Ground Transmitter whose power you want to set | | |
| **Ground Tx L1 EIRP** | Type the transmitter EIRP, in **dBW** or **W**. The display of power against distance updates automatically. | | |
| | Units: dBW (W) | Range: -20 to 26 dBW<br>(0.01 to 398.1 W) | Default: 0 (1 W) |

Alternatively, click **Rx power** to open the dialog below, where you can define the receiver power at a distance you specify:



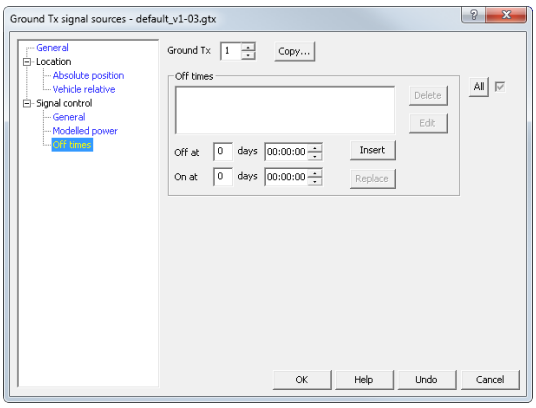

| | | | |
|---|---|---|---|
| **UE power** (receive power) | Units: dBm | Range: -138.8 to -69 dBm | Default: -69 |
| **UE distance from BS**<br>(distance from receiver to Ground Transmitter) | Units metres | Range: 0 to 9E+15 m | Default: 1358.615 |
| ***Note*: *UE power* uses the same power level rules as *Ground Tx EIRP*** | | | |

## 19.4.3 Signal control - Off times

***Note***: *When you set a Ground Transmitter OFF at a specific time, SimGEN sets that Ground Transmitter in the one second (typically 0.6 seconds) before the time you specify. This ensures any replacement hardware channel starts at the correct time.*
*SimGEN does not make this allowance when you set a Ground Transmitter OFF using a User Actions file.*

Set the on / off times for each Ground Transmitter using this dialog:


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| | | | |
|---|---|---|---|
| **Ground Tx** | Select the Ground Transmitter whose settings you want to change. | | |
| **Off at**<br>**On at** | Units:<br>days hh:mm:ss | Range: 0 00:00:00<br>to 23 23:59:59 | Default:<br>0 days 00:00:00 |

Type the **On** time and **Off** time click **Insert**. The times appear in the **Off times** area. There is no limit to the number of **On** and **Off** times.

Select a time in the **Off times** area and click **Edit** to edit the **On** / **Off** times.

Select a time in the **Off times** area and click **Replace** to replace these times with the times currently in the **Off at** and **On at** text boxes.

Select a time in the **Off times** area and click **Delete** to delete these **On** / **Off** times.

Click **All** to apply the times in the **Off times** area to all **Satellites**. A tick next to the **All** button confirms this action.

## 19.5 Signal control (licenced features)

***Licenced features**: You will need a licence to use the increased power this section describes and a separate licence to use the additional modulation types. Contact Spirent for licencing details.*

***Notes:***

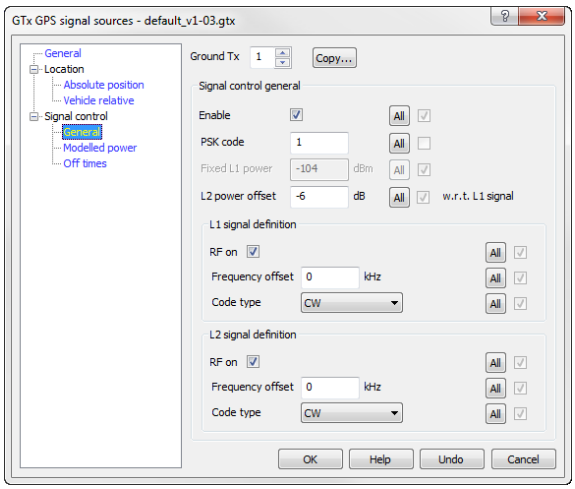
***1)** Currently, Spirent supports these Ground Transmitter features as part of a Tailored Solution (Spirent's term for specialist, non-COTS, products and / or applications). Contact **Spirent Global Services** for further details.*

***2)** The increased power feature uses a modified signal generator. Contact **Spirent Global Services** for further details.*

Use the following sections to set the licenced feature signal parameters for each Ground Transmitter.

### 19.5.1 Signal control - General

Set general signal parameters for each Ground Transmitter using this dialog:





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| | | | | |
|---|---|---|---|---|
| **Ground Tx** | | Select the Ground Transmitter whose signals you want to define | | |
| **Signal control general** | | | | |
| **PSK code** | | Type the PSK sequence for the **Ground Tx** | | |
| | | Units: none | Range: 1 to 16 | Default: same as **Ground Tx** |
| ***Note**: You can use a different PRN sequence (**PSK code**) with each Ground Transmitter* | | | | |
| **Fixed L1 power** | | (disabled if you use **General-signal strength-modelled**)<br>Set the incident power level at the receiver antenna if you use **General-signal strength-fixed** | | |
| | | Units: dBm | Range: -122.8 to -53 dBm | Default: -88 |
| **L2 power offset** | | Set the L2 power offset from L1 | | |
| | | Units: dB | Range: -10 to 10 dB | Default: -6 |
| **L1 signal definition**<br>**L2 signal definition** | | Select the signal options for **L1** and **L2** | | |
| **RF on** | | Select (default): RF on<br>Deselect: RF off | | |
| **Frequency offset** | | Units: kiloHertz | Range: ± 5 000 kHz<br>(10 kHz steps) | Default: 0 |
| **Code type** Choose from: | | | | |
| **CW** | (no settings) | (default) | | |
| **PSK broadband** | (no settings) | Uses a (sin x)/x spectral distribution<br>20.46 MHz main lobe width<br>Approximates wide-band noise, derived from the GPS L5 PRN sequence | | |
| **PSK narrowband** | (no settings) | Uses a (sin x)/x spectral distribution<br>102.3 kHz main lobe width.<br>Approximates narrow-band noise, derived from the GPS L5 PRN sequence | | |
| **CW pulse** | | Pulsed CW signal. Set the pulse width and pulse repetition rate using: | | |
| | **Width** | Units: microseconds | Range: 1 to 10 000 µs | Default: 1 000 |
| | **Repetition interval range** | Units: microseconds | Range: 100 to 10 000 µs | Default: 1 000 |
| **AWGN** | | Set the Additive White Gaussian Noise bandwidth using: | | |
| | **3 dB bandwidth** | Use the drop down menu to select the 3 dB bandwidth from 0.1, 0.5, 1, 2, 10, 20 MHz | | |
| **FM** | | Set the FM modulation parameters (with deviation about the centre frequency) using: | | |
| | **FM deviation±** | Units: MegaHertz | Range: 10 to 5 000 kHz<br>(in 10 kHz steps) | Default: 5 |
| | **FM rate** | Units: kiloHertz | Range: 0.5 to 10 kHz<br>(in 0.5 kHz steps) | Default: 5 |
| **AM** | | Set the AM modulation using: | | |


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| | | | | |
|---|---|---|---|---|
| | **Modulation depth** | Units: percent | Range: 10 to 90% | Default: 50 |
| **PM** | | Set the phase modulation parameters using: | | |
| | **Modulation deviation** | Units: radians | Range: -5 to +5 rad | Default: 5 |
| | **Frequency deviation** | Units: kiloHertz | Range: 0.5 to 10 kHz | Default: 5 |

## 19.5.2 Signal control - Modelled Power

***Note**: When the signal generator cannot provide the receiver power level you want, the power level limits at the signal generator maximum.*

For each frequency band, SimGEN selects the maximum GTx power from the file *…\System data\GTx_power_data.xml*, calculates the offset from the reference power level then uses the largest offset to calculate the UE power, as in these examples:

Example 1:

- Using an L1 GTx power of -46 dBm gives an offset -46 dBm - (-130 dBm) = 84 dB
- Using an L2 GTx power of -49 dBm gives an offset -49 dBm - (-136 dBm) = 87 dB

Here, SimGEN uses the larger offset value of 87 dB with the L1 reference level of -130 dBm, giving -43 dBm receiver (UE) power.

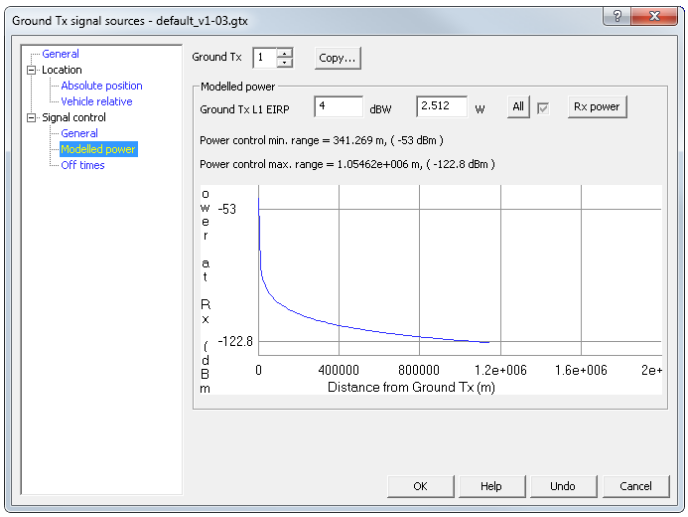
Example 2:

- Using an L1 GTx power of -43 dBm gives an offset -43 dBm - (-130 dBm) = 87 dB
- Using an L2 GTx power of -43 dBm gives an offset -43 dBm - (-136 dBm) = 93 dB

SimGEN uses the larger value of 93 dB against the L1 reference level of -130 dBm, giving -37 dBm UE power.

If you selected ***General*-Signal strength-modelled** (page 19-5), SimGEN configures the modelled power for each Ground Transmitter.

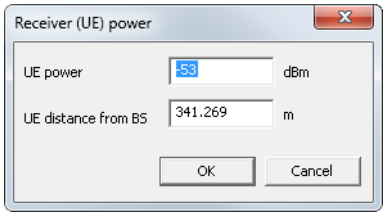
The dynamic power range of each Ground Transmitter is set at 46 dB (licenced feature range: +4 to +50 dB). You can determine the distance over which the receiver antenna experiences a change in power-level using this dialog:




| | |
|---|---|
| **Ground Tx** | Select the Ground Transmitter whose power you want to set |

| | | | |
|---|---|---|---|
| **Ground Tx L1 EIRP** | Type the transmitter EIRP, in **dBW** or **W**. The display of power against distance updates automatically. | | |
| | Units: dBW (W) | Range: 4 to 50 dBW<br>(2.51 to 100 000 W) | Default: 4 (2.51 W) |

Alternatively, click **Rx power** to open the dialog below, where you can define the receiver power at a distance you specify:




| | | | |
|---|---|---|---|
| **UE power** (receive power) | Units: dBm | Range: -122.8 to -53 dBm | Default: -53 |
| **UE distance from BS**<br>(distance from receiver to Ground Transmitter) | Units metres | Range: 0 to 9E+15 m | Default: 341.269 |
| ***Note**: **UE power** uses the same power level rules as **Ground Tx EIRP*** | | | |

### 19.5.3 Signal control - Off times

This dialog is the same as ***Signal control - Off times*** (page 19-10).


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# 20 User-defined data

***Notes**:*

***1)** EVTP is used only in SimGEN for VMS. The file formats for EVTP and SimGEN are identical*

***2)** Currently, only GPS and GLONASS constellations can use User-defined data files*

***3)** SimGEN applies user-defined data in the generation of navigation messages for the modernised GPS signals L1C (CNAV-2), L2C (CNAV) and L5 (CNAV), as well as for the legacy L1C/A signal. However, user-defined data does not support the modernised parameters for the additional health flags and URA components, which you can assign using the **GPS constellation editor** (page 10-1)*

***4)** Use the **GPS constellation editor** (page 10-1), or the **GLONASS constellation editor** (page 11-1) to define signal control parameters, such as **Power Level**, that you cannot specify in user-defined data files*

***5)** You cannot define data for GPS satellites in the **Extended GPS constellation** (page 10-2) (upper PRN set) using user-defined data files*

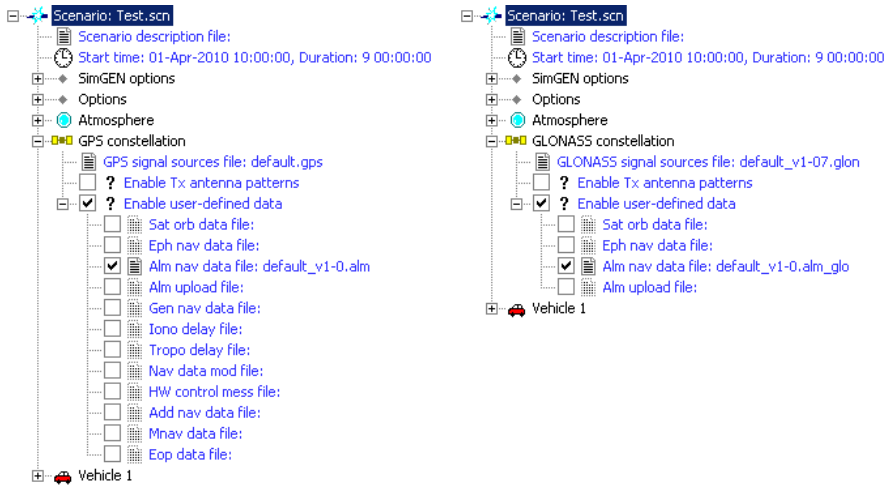
Normally, a SimGEN scenario uses the information you specify in the Constellation file editor, see the ***GPS constellation editor*** (page 10-1), or the ***GLONASS constellation editor*** (page 11-1).

User-defined data files are optional ASCII text files that supplement or modify the data you specify in the GPS or GLONASS constellation (but see Notes above). This data is constellation-dependant and can include satellite motion, Navigation Data, Ionospheric delay, and Tropospheric delay. You must create the user-defined files.

GPS user-defined files do not use an identifier at the end of the extension. GLONASS user-defined files use an extension with the identifier *_glo* at the end of the extension.

To use user-defined files, first select **[Constellation]-Enable user-defined data**, then select the user-defined files you want to use.

The following figures show all the user-defined data files you can specify for the GPS and GLONASS constellations. A tick mark next to **Enable user-defined data** shows this scenario is using one or more user-defined data files. In both figures, the tick mark next to **Alm nav data file:** *default_vx-yy.alm* or *default_vx-yy.alm_glo* shows the scenario is using this user-defined file.




The utility ***GPS L1C/A Nav Data Extract*** (page 26-36) can generate user-defined orbital and ephemeris file data from navigation data that SimGEN logs for the L1C/A navigation message. This can be useful in generating template files or introducing small errors into the ephemeris data.

Spirent recommends you contact ***Spirent Global Services*** (page 28-1) if you need further details on the format of **.alm* and **.eph* files.


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# 20.1 User-defined data - file descriptions

***Note**: You must select **Alm nav data file** to enable **Alm upload file***

The following tables give details on the user-defined data files you can specify for GPS and GLONASS satellites. These tables also give the conditions that apply if you do not specify a user-defined data file. For example, specifying the GPS Alm nav data file gives a normal simulation, with your GPS Alm nav data file providing the broadcast almanac data.


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| GPS file type | Data filename | GPS file extension | File description | Condition if file not specified |
|---|---|---|---|---|
| ***Satellite orbital data file*** (page 20-5) | Sat orb data file | **.eph* | Defines the motion of simulated GPS satellites<br>The utility ***GPS L1C/A Nav Data Extract*** (page 26-36) can generate data in UDD format | The orbital parameters you specify in the GPS Constellation file determine the satellite motion |
| ***Ephemeris navigation data file*** (page 20-6) | Eph nav data file | **.eph* | Defines broadcast Navigation Data for satellite ephemeris and clock parameters.<br>Same format as ***Satellite orbital data file***<br>The utility ***GPS L1C/A Nav Data Extract*** (page 26-36) can generate data in UDD format | Orbital data from ***Satellite orbital data file***, or from the GPS Constellation file, generates the broadcast data |
| ***Almanac navigation data file*** (page 20-7) | Alm nav data file | **.alm* | Defines broadcast almanac data for the satellite orbits. Select to enable Almanac Upload file | Applicable ephemeris data (whatever its source) determines the broadcast almanac data.<br>Disables Almanac Upload file |
| ***Almanac upload file*** (page 20-7) | Alm upload file | **.alm* | Defines broadcast almanac data for the satellite orbits after an upload | Broadcast almanac data does not change during the simulation |
| ***General navigation data file*** (page 20-8) | Gen nav data file | **.gbl* | Defines various Navigation Data fields such as the UTC parameters and Ionospheric coefficients | Navigation Data is as for a “normal” run |
| ***Ionospheric delay file*** (page 20-8) | Iono delay file | **.ion* | Defines the Ionospheric delay characteristics over a given period for each satellite using a simple quadratic expression | Determines Ionospheric delay using the coefficients of the Klobuchar model broadcast in the Navigation Data, or the fixed delay you specify in the GPS Constellation file |
| ***Tropospheric delay file*** (page 20-10) | Tropo delay file | **.tro* | Defines the Tropospheric delay characteristics over a given period for each satellite using a simple quadratic expression | Uses the Tropospheric delay model you specify in the GPS Constellation file |
| ***Navigation data modification file*** (page 20-10) | Nav data mod file | **.nav* | Overwrites selected elements of the broadcast Navigation Data message for specified GPS satellites | Uses the Navigation Data you specify in the GPS Constellation file |
| ***Hardware control message file*** (page 20-14) | HW control mess file | **.hw_msg* | Transmits commands to the signal generator at specified times | Does not send commands at specific times to the signal generator |


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| GPS file type | Data filename | GPS file extension | File description | Condition if file not specified |
|---|---|---|---|---|
| | Add nav data file | *.*add* | See reference vv) | Navigation Data is as for a “normal” run |
| | Mnav data file | *.*mnv* | See reference uu) | Navigation Data is as for a “normal” run |
| | Eop data file | *.*seo* | See reference vv) | Navigation Data is as for a “normal” run |

| GLONASS file type | Data filename | GLONASS file extension | File description | Condition if file not specified |
|---|---|---|---|---|
| ***Satellite orbital data file*** (page 20-16) | Sat orb data file | *.*eph_glo* | Defines the motion of simulated GLONASS satellites | The orbital parameters you specify in the GLONASS Constellation file determine the satellite motion |
| ***Ephemeris navigation data file***(page 20-19) | Eph nav data file | *.*eph_glo* | Defines broadcast Navigation Data for satellite ephemeris and clock parameters. Same format as **GLONASS-*Satellite orbital data file*** | Orbital data from **GLONASS-*Satellite orbital data file***, or from the GLONASS Constellation file, generates the broadcast data |
| ***Almanac navigation data file*** (page 20-19) | Alm nav data file | *.*alm_glo* | Defines broadcast almanac data for the satellite orbits. Select to enable Almanac Upload file | Applicable ephemeris data (whatever its source) determines the broadcast almanac data. Disables Almanac Upload file |
| ***Almanac upload file*** (page 20-22) | Alm upload file | *.*alm_glo* | Defines broadcast almanac data for the satellite orbits after an upload | Broadcast almanac data does not change during the simulation |


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# 20.2 GPS user-defined data files

The following section detail the user-defined data files you can use with GPS satellites.

## 20.2.1 Satellite orbital data file

This file (*.*eph*) determines the GPS satellite motion during the simulation. It is an ASCII file containing a time-ordered sequence of datasets. These datasets define orbital and other parameters for all simulated satellites. The example file below gives the format of each dataset:

```
CUTOVER_RAMP_PERIOD: cutover_period_i
**** Week 0893 at GPS time 601200.00 ephemeris for SV-23 ***********
ID:                                                         23
Health:                                                     0
Issue of Data(Ephemeris):                                   120
Sine Harm Corr Term to Orb rad(Crs,meters):                 -5.25000000000e+00
Mean Motion Difference (delta n,semi-circles/sec):          1.50430423673e-09
Mean Anomaly (semi-circles):                                9.91738925222e-01
Cos Harm Corr Term to Arg Lat (Cuc,radians):                -2.84984707832e-07
Eccentricity:                                               1.18420945946e-02
Sine Harm Corr Term to Arg Lat (Cus,radians):               5.89154660702e-06
Sqrt(A)(meters):                                            5.15362767792e+03
Time of ephemeris (toe,seconds):                            0
Cos Harm Corr Term to Angle of Incl (Cic,radians):          4.84287738800e-08
Right Ascension (omega0,semi-circles):                      -9.28051709197e-01
Sine Harm Corr Term to Angle of Incl (Cis,radians):         -2.51457095146e-07
Inclination Angle at Reference Time (i0,semi-circles):      3.07477083988e-01
Cos Harm Corr Term to Orbit Radius (Crc,meters):            2.65062500000e+02
Arg of Perigee (w,semi-circles):                            -6.73587591853e-01
Rate of Right Ascension (omegadot,semi-circles/sec):        -2.54385668086e-09
Rate of Inclination Angle (IDOT,semi-circles/sec):          5.07043296238e-11
C/A or P on L2 Bits (discretes):                            01
HOW bit 18:                                                 0
HOW bit 19:                                                 1
URA Index:                                                  0007
ISSUE OF DATA CLOCK:                                        0888
L2 P data flag:                                             0
Estimated Group Delay Differential (sec):                   -4.65661287308e-10
Clock Data Reference Time (sec):                            0
Second order coefficient af2(sec/sec**2):                   0.00000000000e+00
First order coefficient af1(sec/sec):                       3.41060513165e-13
zero order coefficient af0(sec):                            5.46686351299e-07
Ephemeris reference week number:                            0893
```

Conditions

1) The first line of the file (before ANY datasets) defines the cutover period. This uses a keyword and associated parameter (`CUTOVER_RAMP_PERIOD: cutover_period_i`) to set the transition time between the motion and clock errors defined by one dataset and the motion and clock errors defined in the next dataset. The parameter `cutover_period_i` is an integer in the range zero to 7 200 seconds (one second steps). Here, zero seconds is equal to one simulation step, as set by ***General Options*** **-Simulation iteration rate** (page 4-15)
Up to SimGEN version 2-89, `cutover_period_i` was fixed at 60 seconds.

If you specify `cutover_period_i` to be less than one second, SimGEN uses a period of one simulation timestep; if you specify `cutover_period_i` to be greater than 7 200 seconds, SimGEN uses 7 200 seconds.
If you do not specify this keyword, SimGEN uses a cutover period of 60 seconds.

2) Asterisks enclose the second line of data, which defines the acquisition time for the data and when it becomes current. Normally, the time for the first set of data for each satellite is not too different from the scenario start time otherwise the validity of the data is questionable.
It automatically compensates for week number rollover when applicable.

3) You can add comments between one completed dataset and the next. The comments must not include lines with an asterisk in the first column.

4) Each set of data applies from the point at which the run reaches the time of acquisition of the data until superseded by a following set. The first set is always current when the start of the run is earlier than the time of this set.

5) Consecutive ephemeris sets for real satellites will exhibit some degree of divergence from one another with time. To avoid discontinuity when switching from one set to the next, SimGEN determines the applied satellite motion from the current ephemeris set up to a point that is one minute before a new set is due for transmission. SimGEN translates the calculation of the satellite position from the current to the next set so that, from the cutover time, only


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the new set is applied.
SimGEN treats clock data in the same way.

6) The data is referenced to the time of ephemeris and time of clock for each dataset.

7) The simulation disables satellites not having datasets defined in this file.

8) You can use any number of data sets.

### 20.2.2 Ephemeris navigation data file

***Notes**:*

***1)** If you use **Ephemeris navigation data file**, you must ensure the Navigation Data is consistent with satellite motion.*

***2)** Enabling **Eph nav data file** and selecting an appropriate file also overrides settings in **Signal Control - Upload details** (page 10-48).*

This file (**.eph*) has the same format as ***Satellite orbital data file*** (page 20-5), including the position of the CUTOVER_RAMP_PERIOD keyword. The information in each dataset defines the Navigation Data message for a satellite.

Generally, SimGEN reads the parameters in each dataset as floating or integer data, as relevant. After scaling, SimGEN inserts these parameters directly into the appropriate field of the Navigation Data message for the transmitting satellite. This table gives details on specific parameters in the Navigation Data message.

| Parameter | Detail |
|---|---|
| Health | Read as a decimal value.<br>It defines the six SV health bits in subframe 1, word 3 |
| C/A or P on L2 | Read as two binary bits, to be inserted in frame 1, word 3 |
| How bit 18 | Read as a single binary bit, to be inserted in the HOW |
| How bit 19 | Read as a single binary bit, to be inserted in the HOW |
| URA Index | Read as a decimal value. It defines the 4-bit URA field |
| L2 P data flag | Read as a single binary bit, to be inserted in subframe 1, word 4 |
| Fit Interval Flag | Subframe 2, word 10<br>Set to 0 (4 hour sets) if the time difference between the acquisition time of the datasets and the corresponding ephemeris reference time (toe) is no more than two hours.<br>Otherwise, set to 1 (6 hour sets) |

Conditions:

1) The first line of the file (before ANY datasets) defines the cutover period. This uses a keyword and associated parameter (`CUTOVER_RAMP_PERIOD: cutover_period_i`) to set the transition time between the motion and clock errors defined by one dataset and the motion and clock errors defined in the next dataset. The parameter `cutover_period_i` is an integer in the range zero to 7 200 seconds (one second steps). Here, zero seconds is equal to one simulation timestep, as set by ***General Options*** **-Simulation Iteration Rate** (page 5-15).
Up to SimGEN version 2-89, `cutover_period_i` was fixed at 60 seconds.

If you specify `cutover_period_i` to be less than one second, SimGEN uses a period of one simulation timestep; if you specify `cutover_period_i` to be greater than 7 200 seconds, SimGEN uses 7 200 seconds.
If you do not specify this keyword, SimGEN uses a cutover period of 60 seconds.

2) Asterisks enclose the second line of data, which defines the time from which a set of data is broadcast until superseded by the next set (if any). It automatically compensates for week number rollover when applicable.

3) You can add comments between one completed dataset and the next. The comments must not include lines with an asterisk in the first column.

4) Changeover to a new dataset can occur at any time (nominally on a 6-second boundary) but will normally be at a cutover time (a two-hourly boundary) or an upload. SimGEN does not place any restrictions on these times.

5) The simulation will not use a satellite if its last dataset is more than 6 hours before the start time of the scenario.

6) You can use any number of data sets



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### 20.2.3 Almanac navigation data file

***Notes**:*

***1)** If you use this file, you must ensure the Navigation Data is consistent with satellite motion*

***2)** If you omit this file, you cannot specify an **Almanac upload file** (page 20-7)*

This file (**.alm*) defines the almanac data in the GPS Navigation Message. It is an ASCII file containing one dataset per satellite. The format of each dataset is as follows:

```
**** Week 893 at GPS time 601200 almanac for SV- 1 ***********
ID:                                  1
Health:                              000
Eccentricity:                        3.85475158691e-03
Time of Applicability(s):            147456
Orbital Inclination (rad):           1.18643826563e-02
Rate of Right Ascen(rad/s):          -8.04604943597e-09
SQRT(A)  (m^1/2):                    5153.685059
Right Ascen at TOA(rad):             -1.88751916766e+00
Argument of Perigee(rad):            -1.57416014892e+00
Mean Anom(rad):                      -2.71030399319e+00
Af0(s):                              2.19345092773e-05
Af1(s/s):                            0.00000000000e+00
week:                                894
```

Conditions

1) Asterisks enclose the first line of data, which defines the time of acquisition of the data. However, the initial almanac assignment applies from the start of the run.

2) You can add comments between one completed dataset and the next. The comments must not include lines with an asterisk in the first column.

3) After scaling, SimGEN writes the data to the relevant almanac data fields in subframes 4 and 5 of the Navigation Data. SimGEN reads the parameters as floating point or integer data, with the exception of the **Health** field, which it reads as a three character octal value (as is the case for Yuma almanac format). SimGEN writes the health settings to the 8-bit health field in each of the 32 pages containing the almanac data sets and defines the table of 6-bit health status values in page 25 of subframes 4 and 5. SimGEN directly equates the least-significant five bits and the most significant bit is a composite of the other bits in the source data. The value of **SVHEALTH** you specify in ***General navigation data file*** (page 20-8) supersedes the 6-bit health settings.

4) The almanac data you supply for a satellite is valid throughout the run unless superseded by an ***Almanac upload file***. SimGEN uses the first set of the ***Ephemeris navigation data file*** (page 20-6), to generate an almanac data for each satellite not included in an ***Almanac upload file***. This also applies if there is no almanac data file.

***Note**: In this case, SimGEN generates only one set of almanac data, with toa set to approximately 3.5 days after the start of the run. SimGEN designates satellites for which there are no almanac data and no ephemeris data as dummy satellites and sets the SV ID to zero in the Navigation message.*

5) If you do not use user-defined ephemeris or almanac files, SimGEN generates almanac data using the orbital data T and upload times you define in the GPS constellation file.

6) You can define the orbital inclination value in this file as an absolute value or as an offset from 0.3 semi-circles. If the magnitude of this parameter is less than 0.196 radians it is automatically adjusted by 0.3 semi-circles.

### 20.2.4 Almanac upload file

***Note**: You must specify an **Almanac navigation data file** (page 20-7), before you can use an **Almanac upload file**.*

This file (**.alm*) has the same format as ***Almanac navigation data file***.

For a given satellite, the first line of the almanac dataset (the acquisition time) determines the upload time. The data in ***Almanac upload file*** replaces the almanac data the satellite was using.

You must correctly align the upload time for the almanac with a corresponding change in ephemeris/clock data for that satellite.


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### 20.2.5 General navigation data file

Use this file (*.*gbl*) to change certain parameters in the Navigation Data message. It is an ASCII file, containing one dataset for each satellite. The format of each dataset is as follows:

```
****** SV-1 GLOBAL PARAMETERS ***********
UTC
A0(s):                                  0.
A1(s/s):                                0.
DeltatLS(s):                            0
tot(s):                                 0
WNt(weeks):                             0
WNlsf(weeks):                           0
DN(days):                               0
deltatlsf(s):                           0
IONO
a0(s):                                  0.
a1(s/semi-circle):                      0.
a2(s/semi-circle^2):                    0.
a3(s/semi-circle^3):                    0.
b0(s):                                  0.
b1(s/semi-circle):                      0.
b2(s/semi-circle^2):                    0.
b3(s/semi-circle^3):                    0.
REMAINING
AS/SVCFG (4 BITS):                      0x5
SVHEALTH (6 BITS):                      0x00
SPARE BIT PATTERN (2BITS):              0x2
2 NON INFORMATION BIT PATTERN:          0x0
SPECIAL MESSAGE(22 CHAR):               *1234567890123456789012*
```

Generally, after scaling, the data read from this file replaces the data defined in normal operation. SimGEN inserts the new data directly at the appropriate locations in the Navigation Data.

Conditions

1) Asterisks enclose the first line of data.

2) You can add comments between one completed dataset and the next. The comments must not include lines with an asterisk in the first column.

3) You can include or omit satellites, as required.

4) For all satellites you include, you must define all data fields.

5) The Ionospheric coefficients a0 to a3 and b0 to b3 in the above listing supersede **Alpha 0** to **Alpha 3** and **Beta 0** to **Beta 3** in ***Terrestrial iono model - GPS and default model*** (page 9-3). SimGEN inserts these coefficients in the navigation data stream and uses them to calculate the applied ionospheric delay when the Klobuchar model is in use (that is, when the ionospheric delay is not set to fixed in **Atmosphere file-*Ionospheric model*** (page9-2), or you use ***Ionospheric delay file*** (page 20-8) to explicitly define the values of these coefficients.

***Note**: Normally the Ionospheric coefficients are the same for all satellites, although you can specify different coefficients for each satellite.*

6) SimGEN reads all bit pattern fields in hexadecimal format.

7) SimGEN assigns the AS/SVFG bits to the 4-bit fields, which contain this information in subframe 4 page 25.

8) SimGEN assigns the SVHEALTH bits to the 6-bit health fields in subframe 5 page 25 (1-24) and subframe 4 page 25 (25-32) only.
These values supersede those in the GPS constellation file and / or the Alm nav data file at these locations.

9) SimGEN does not currently apply the bit patterns for SPARE and NON-INFORMATION bits.

10) SPECIAL MESSAGE is the 22-character text field delimited by asterisks. SimGEN writes it to subframe 4 page 17.

11) The number of datasets you can use has no limit.

### 20.2.6 Ionospheric delay file

This file (*.*ion*) directly assigns Ionospheric delay.

Example Iono delay file:

```
*WEEK 894
! Time SVID    Type    Delay   Rate    Acc'n
 0     3     1     0.6e-8  0.1e-8  0.0
 24    22    1     0.1e-10 0.1e-14 0.2e-18
```


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```
12022    0
```

These entries specify for week 894:

1) At TOW = zero seconds, satellite 3 switches to explicit data type and uses the delay parameters shown

2) At TOW = 24 s, satellite 22 switches to explicit data type and uses the parameters shown

3) At TOW = 120 s, satellite 22 switches to modelled data type

Conditions:

1) Any lines with an '**!**' in the first column are treated as comments.

2) The first line in the file is optional and contains the week number corresponding to the start time of the data.

3) The Time of each set of data must correspond with a 6-second epoch.

4) To enable the Iono delay file, first select **Atmosphere-*Ionospheric model*-Ionospheric delay models-Constellation defaults** or **-GPS in all cases** (page 9-2).

5) Selecting **Atmosphere-*Ionospheric model*-Ionospheric delay models** applies the Klobuchar model for GPS and uses the Ionospheric coefficients a0 to a3 and b0 to b3 in the listing shown in ***General navigation data file*** (page 20-8); notice the details in condition 5) of that section also apply.

6) At the start of the simulation, the default Type is 0 (Modelled).

7) Type 1 (Explicit) uses this quadratic equation to determine Ionospheric delay:

$$\text{Iono Delay} = D + Rt + 0.5At^2$$

Where: t = Current time in run - $T_a$ (equated to time in run)
and D, R, A are delay coefficients

8) Type 0 (Modelled) does not use delay coefficients D, R and A. Do not enter values for them.

9) When you change sets of coefficients or switch between Modelled and Explicit, there may be discontinuity at the changeover time. This will result in transitory increases in pseudorange acceleration and jerk - perhaps exceeding the dynamic limits of the signal generator (an over-range error).
The short (100-millisecond) duration of these discontinuities will not result in any net loss in accuracy over the simulation; however, Spirent recommends you minimise them.

This table shows the format of the lines in the Iono delay file.

| Record name | Record format | Description (units) |
|---|---|---|
| WEEK NUMBER | *WEEK: *nnnn*<br>*nnnn* is the week number, range 0 - 1023 | The week number compensates for week rollover when applicable. If omitted, assumes the week number applicable at the start of the run. |
| The data format consists of a time-ordered sequence of values for Ionospheric delay, each line containing the following fields: | | |
| Time ($T_a$) | TOW: *nnnnnn*<br>*nnnnnn* is the time-of-week<br>Range: 0 - 403196 | The GPS Time-of-Week (seconds) from which this dataset applies |
| SVID | SVID: *nn*<br>*nn* is the satellite ID<br>Range 0 to 32 | The satellite ID (PRN) |
| Type | Type: *n*<br>*n* = 0 Modelled data type (default)<br>*n* = 1 Explicit data type | Sets the data Type to use |
| Delay (D) | Contact Spirent for parameter limits | The Ionospheric delay at the reference time (s) |
| Rate (R) | Contact Spirent for parameter limits | The delay rate coefficient at the reference time ($s.s^{-1}$) |
| Accel (A) | Contact Spirent for parameter limits | The delay acceleration coefficient ($s.s^{-2}$) |


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### 20.2.7 Tropospheric delay file

This file (*.tro) has exactly the same format as ***Ionospheric delay file*** (page 20-8) and defines the Tropospheric delay.

Use this data file in the same way as ***Ionospheric delay file***. However, Type: 0 (Modelled) defaults to the model you specify in **Atmosphere-*Tropospheric model*-Tropospheric delay** (page 9-1).

### 20.2.8 Navigation data modification file

***Note***: *Regardless of your choice of* ***Subframe****, you must also specify the* ***Page*** *to which the navigation data modifications apply*

*The ability to modify a single page offers greater control, although* ***Subframe 1*** *to* ***Subframe 3*** *contains the same data on all pages.*

Use this file (*.nav) to insert data in the broadcast GPS Navigation Data message, overwriting the data SimGEN normally generates. You must specify the changes to the Navigation Data **Subframe**, **Page** and **Word**, together with the changes to the appropriate bits in the word. You can apply the changes to all satellites or to specific satellites.

The following two tables show the format of the lines in the Navigation data modification file.

**Up to TIME record**

| Record name | Format | Description |
|---|---|---|
| COMMENT | "!" preceding up to 80 characters | Use to add comments (or a title). You can place comments at any point in the file |
| WEEK NUMBER | WEEK: *nnnn*<br>*nnnn* is the week number, range 0 to 1 023. Week number rollover is implicit according to the start time of the scenario | Occurs once in each file and followed by a sequence of lines defining the changes to be applied at the specified time to the specified satellites |
| Each sequence of records consists of: | | |
| TIME | TOW: *nnnnnn*<br>*nnnnnn* is the time-of-week<br>Range: 0 to 403 196 | Time-of-week as Z-count (the number of 1.5 second epochs into the week)<br>TIME applies to all subsequent records until superseded by the next TIME record |

**After TIME record**

A data set for each satellite whose Navigation Data you want to modify follows the TIME record. Each data set comprises a SATELLITE ID and a variable number of NAVIGATION DATA records that let you change a specific Navigation Data word.

| Record name | Format | Description |
|---|---|---|
| SATELLITE ID | SVID: nn<br>nn is the satellite ID<br>Range 0 to 32<br>If SVID = 0 the changes apply to all satellites | The satellite ID to which the data changes apply |


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| Record name | Format | Description |
|---|---|---|
| NAVIGATION DATA | SF n1:P n2:W n3:B n4-n5: abcdef<br>Where:<br>SF, P, W, B - text characters in the file.<br>n1 - the number of the subframe to be changed (set to zero to apply to all subframes).<br>n2 - the number of the page to be changed (set to zero to apply to all pages of the given subframe).<br>n3 - the number of the word to be changed (set to zero to apply to all words of the given subframe/page).<br>n4 - the first bit of the GPS Navigation Data word to be changed.<br>n5 - the last bit of the GPS Navigation Data word to be changed.<br>The GPS bit range is from 1 to 24.<br>You cannot edit the parity bits (range 25 to 30); they will be correctly defined by default.<br><br>abcdef is a hexadecimal character string defining bits to be used as bits 1 to 24 in the GPS Nav Data word, such that:<br>Each character represents four bits of the 24 bit editable range.<br>The most significant bit of "a" corresponds to bit 1 of the GPS Nav word.<br>The least-significant bit of "f" corresponds to bit 24 of the GPS Nav word.<br>Only those bits within the specified range of n4 to n5 are used. | A series of records defining changes for the satellite. |

Further SATELLITE ID and NAVIGATION DATA records follow for this TIME.
After the next TIME record (if any) further SATELLITE ID and NAVIGATION DATA records follow.
See the example file.

Conditions:

1) The Navigation data changes apply indefinitely, until you define a new set of changes for a given satellite. The new changes will overwrite all previous changes for this satellite.

2) If there are no NAVIGATION DATA records following the SATELLITE ID record SimGEN reverts to generating default Navigation Data.

3) If you use SAAS software, SimGEN applies these changes before passing the Navigation Data subframes to the SAAS software.

4) SimGEN skips blank lines in the file.

Example file format:

```
! Header comment
WEEK:  34
TOW:123456
!The following Nav Data changes apply to all satellites
SVID:  0
! Set bits 21 and 22 to 1 in word 8 and 9 for all pages of subframe 1
SF 1:  P 0: W 8: B 21-22:   00000C
SF 1:  P 0: W 9: B 21-22:   00000C
! Following changes apply to SV1 only
SVID:  1
SF 4:  P 12:W 9:  B 9-24: 001234
SF 4:  P 12:W 10:B 1-22: 123456
SF 4:  P 15:W 9:  B 1-24: FFFFFF
! Change for SV4
SVID:  4
```


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```
SF 4:  P 12:W 8:  B 1-24: 00000F
!
TOW:123800
! Clear all changes specific to SV1 (Global changes still apply)
SVID:  1
! Changes for SV 5
SVID:  5
SF 1:  P 0: W 6:  B 21-22:   00000C
SF 1:  P 0: W 7:  B 21-22:   00000C
!
TOW:   123900
! Clear all changes for all SVs
SVID:  0
! end
```

#### 20.2.8.1 L2C-NAV user-defined data file

Use this file (**.cnav*) to insert data in the broadcast GPS Navigation Data message, overwriting the data SimGEN normally generates. You must specify the Navigation Data **Message sequence** and **Message data**. You can apply the changes to all satellites or to specific satellites.

There is no limit to the length of this file.

An undefined message in this data file results in the use of a message that SimGEN generates.

The following table shows the format of the lines in the L2C-NAV data modification file:

| Record name | Format | Description |
|---|---|---|
| COMMENT | "!" preceding up to 80 characters | Use to add comments (or a title). You can place comments at any point in the file |
| WEEK NUMBER (13-BIT and 10-BIT) | WEEK NUMBER (13-BIT): xxxx<br>WEEK NUMBER (10-BIT): yyy<br>*xxxx* and *yyy* are the week numbers given as 10-bit and 13-bit numbers, range 0 to 1 023.<br>Week number rollover is implicit according to the start time of the scenario. | Can occur more than once in each file. Followed by a sequence of lines defining the message sequence and message data to be applied at the specified time to the specified satellites |
| Each sequence of records consists of: | | |
| TIME | TOW: *nnnnnn*<br>*nnnnnn* is the time-of-week<br>Range: 0 to 403 196 | Time-of-week as Z-count (the number of 1.5 second epochs into the week)<br>TIME applies to all subsequent records until superseded by the next TIME record |
| SATELLITE ID | SVID: nn (or a comma-separated series)<br>nn (or nn, mm, pp, …) is the satellite ID<br>Range 0 to 32<br>If SVID = 0 the changes apply to all satellites | The satellite ID to which the data changes apply |
| MESSAGE SEQUENCE | MESSAGE SEQUENCE: aa-bb-cc-dd-…<br>aa-bb-cc-dd-… represents the message type numbers. These are the **Message types** in ***Nav data mods - Command type - L2C Nav Data Mod*** (page 10-19) | Defines the message sequence until the next TOW.<br>You can apply a series of message types by separating the message sequence with semi-colons:<br>aa-bb-cc-dd; ee-ff-gg-hh; ii-jj-kk-ll; …. |


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| Record name | Format | Description |
|---|---|---|
| MESSAGE DATA | Data is hexadecimal, as follows:<br>1) 69 hexadecimal characters<br>(276 bit message)<br>Message needs to apply parity, followed by FEC<br>2) 75 hexadecimal characters<br>(300 bit message)<br>Message includes parity, need to apply FEC<br>3) 150 symbols post-FEC<br>(600 bit message)<br>Message includes parity and FEC, ready for broadcast | Message data you want to use |

Conditions:

1) The Navigation data changes apply indefinitely, until you define a new set of changes for a given satellite. The new changes will overwrite all previous changes for this satellite.

2) If there are no NAVIGATION DATA records following the SATELLITE ID record SimGEN reverts to generating default Navigation Data.

3) If you use SAAS software, SimGEN applies these changes before passing the Navigation Data subframes to the SAAS software.

4) SimGEN skips blank lines in the file.

Example file listing:

```
! Comment line
WEEK NUMBER(13-BIT): 1846
WEEK NUMBER(10-BIT): 822
TOW: 345600
SVID: 1
MESSAGE SEQUENCE: 10-11-30-15
MESSAGE TYPE 30:
!69 hex characters
8B04AA8C10D9C000036C00E6832000000000000000041692DE28000000033C1BAB860
SVID: 2
MESSAGE SEQUENCE: 10-11-30-15
SVID: 3
MESSAGE SEQUENCE: 11-10-32-15
MESSAGE TYPE 11:
8B04AA8C10D9C000036C00E6832ABAB0000000000041692DE28000000033C1BAB860
MESSAGE TYPE 10:
8B04AA8C10D9C000036C00E6832ABABABAB0000000041692DE28000000033C1BAB860
MESSAGE TYPE 32:
8B04AA8C10D9C000036C00E6832ABAB000001234564441692DE28000000033C1BAB860
MESSAGE TYPE 15:
!75 hex characters
8B04AA8C10D9C000036C00E6832ABAB0000000000000041692DE28000000033C1BABABACD4367
TOW: 345632
SVID: 1
MESSAGE SEQUENCE: 10-11-30-28
MESSAGE TYPE 28:
8B04AA8C10D9C000036C00E6832ABAB0000000000000041692DE28000000033C1BAB86A
SVID: 2
MESSAGE SEQUENCE: 10-11-30-28
MESSAGE TYPE 28:
8B04AA8C10D9C000036C00E6832ABAB0000000000000041692DE28000000033C1BAB86A
WEEK NUMBER(13-BIT): 1847
WEEK NUMBER(10-BIT): 823
TOW: 0
SVID: 1
MESSAGE SEQUENCE: 10-11-30-15
MESSAGE TYPE 15:
8B04AA8C10D9C000036C00E6832ABAB0000001230004 1692DE28000000033C1BAB86A
SVID: 2
MESSAGE SEQUENCE: 10-11-35-28
```


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```
MESSAGE TYPE 28:
8B04AA8C10D9C000036C00E6832ABAB00012300000041692DE28000000033C1BAB86A
SVID: 3, 4, 5
MESSAGE SEQUENCE: 10-11-35-28
MESSAGE TYPE 28:
8B04AA8C10D9C000036C00E6832ABAB00012300000041692DE28000000033C1BAB86A
```

### 20.2.9 Hardware control message file

***Important Note**: This file is for internal use by Spirent. Only use this file under the guidance and instruction of Spirent. You must define the messages so the signal generator recognises them and uses them in the correct context. Only a limited number of the available messages are appropriate during the run.*

***Notes**:*

***1)** User-defined A-S control messages supersede those normally generated by the SAAS software. In this case, you must enable anti-spoofing as normal. The SAAS source file determines A-S on/off times for individual satellites. The SAAS software must transmit the first A-S control message. Invalid or delayed transmission of A-S data will result in an error in simulator operation.*

***2)** SimGEN skips blank lines in this file.*

***3)** The maximum application rate is three messages per second.*

***4)** SimGEN may concatenate separate GPIB messages that apply at the same time for the same signal generator into a single message in the file, providing you do not exceed the maximum message length (including "CPUS n " ) of 120 bytes.*

***5)** SimGEN does not check message syntax and assumes any line, which is not a comment, or does not begin with one of the above keywords, contains a valid hardware control message.*
*The signal generator will reject invalid messages, which may cause the run to fail.*

This file (**.hhw_msg*) controls the timing and content of hardware control messages sent to the signal generator while running a scenario. The message protocols are IEEE-488 or IP depending on your signal generator.

This table shows the format of the records (lines) in the ASCII Hardware control message file.

| Record name | Record format | Description |
|---|---|---|
| COMMENT | "!" preceding up to 80 characters | Use to add comments (or a title). You can place comments at any point in the file. |
| WEEK NUMBER | WEEK: nnnn<br>nnnn is the week number, range 0 - 1023. Week number rollover is implicit according to the start time of the scenario. | The Week Number record occurs once in each file and must be the first data record. It is the GPS week number for which the data is initially referenced.<br>You must still assign an arbitrary value if you specify all message times as time into run. |
| TIME ADVANCE | TADV: *nn*<br>*nn* is the number of seconds to advance, range 0 to 60. | (Optional) Use to advance transmission of all messages by the given number of seconds.<br>If not used, each message is sent to the signal generator at the TIME you specify |
| A sequence of control records, see below, follow the above records | | |


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| Record name | Record format | Description |
|---|---|---|
| TIME | TOW: *nnnnnn*<br>*nnnnnn* is the TOW expressed as a Z-count<br>Range: 0 - 403196<br>The range must correspond to a 6-second epoch or is rounded down<br><br>TOWS: *nnnnnn*<br>*nnnnnn* is the TOW expressed in seconds<br>Range: 0 - 604799<br><br>TRUN: *nnnnnn*<br>*nnnnnn* is the time into the scenario run expressed in seconds<br>Range: 0 - maximum scenario duration in seconds. | Time-of-week (TOW) SimGEN sends the message to the signal generator. You can specify Z-count (1.5 second epochs), seconds or time into run (seconds).<br><br>TIME applies to all subsequent records until superseded by the next TIME record. |
| HARDWARE TYPE | TYPE: unit_type<br>unit_type is GPS. | This defines the type of signal generator<br><br>HARDWARE TYPE applies until superseded by another HARDWARE TYPE record |

***Note***: *Currently, Spirent does not implement the HARDWARE TYPE record. Messages sent only to GPS signal generators (the 'unit')*

| | | |
|---|---|---|
| HARDWARE UNIT | UNIT: *unit*<br>*unit* is the IEEE-488 address<br>Range: 1 to 30<br>Default: 1<br><br>OR<br>*unit* is an IP address of the form 10.24.1.123 | Address of a specific signal generator.<br>If you do not specify a signal generator address using HARDWARE UNIT, SimGEN sends messages to all signal generators.<br>The HARDWARE UNIT you select applies until superseded by another HARDWARE UNIT record |

***Note***: *Currently, Spirent does not implement the HARDWARE UNIT record. Messages sent only to GPS signal generators (the 'unit')*

| | | |
|---|---|---|
| CPU / OUTPUT | CPU: *n*<br>*n* is 1, 2 or 3<br>Default: 3 (messages are sent to both CPUs) | Determines which CPU / Output is being addressed for the current signal generator.<br>The CPU / OUTPUT selection applies until superseded by another CPU / OUTPUT message |
| Transmitted Message | For example, the following message could be used to select P-code only on the L1 carrier for hardware channel 0:<br>CHAN 0 L1CO 0 | You must correctly format messages to the signal generator. Generally, SimGEN transmits GPIB messages as entered, with the appropriate CPUS message automatically added to the start of the transmitted string |


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## 20.3 GLONASS user-defined data files

***Note**: SimGEN version 4.03 includes the first implementation of UDD (User Defined Data ) for the GLONASS constellation. The following are known limitations with this release:*

*1) The method used to generate Keplerian orbital data from the User-defined position, velocity and acceleration data in the orbital data file is not optimal and may be refined in a future release. This produces small differences from the expected orbit for the first ephemeris set, but larger errors as the time of ephemeris increases with respect to the scenario start time for subsequent sets.*

*2) The satellite motion calculated in the cutover_period between ephemeris data sets shows a smooth transition in position, but noise on the velocities.*

The following sections detail the user-defined data files you can use with GLONASS satellites.

So that SimGEN correctly parses the GLONASS user-defined data files:

- Format the record header lines (all lines beginning with ****) as in the examples.
- Lines beginning with "//" are comment lines that SimGEN will ignore.
- You must enter the labels exactly as in the examples, including the ":" terminator.
- You can separate data from its label by any number of tabs or spaces.

### 20.3.1 Satellite orbital data file

This file (**.eph_glo*) determines the GLONASS satellite motion during the simulation. It is an ASCII file containing a time-ordered sequence of datasets. Each datasets define orbital and other parameters for a set of satellites. Satellites not included in the set will not be simulated. Those in the set will be simulated if visible at the simulated receiver position (and sufficient simulator channels are available)

The example file below shows two consecutive datasets, each set containing the data for satellites 1 and 2 only. Normally, each data set defines all satellites in the constellation you want to simulate.

```
// Example GLONASS UDD Ephemeris file
// Pos, vel in km, km/s
CUTOVER_RAMP_PERIOD: 60
**** ephemeris for GLONASS SV 1 ref time 02-Sep-2012 00:15:00 UTC period 30
freq_carrier_dev:      0
time_scale_shift:      0.000177043
x_coord:          2817.76367188
y_coord:          24919.2324219
z_coord:          -4698.22216797
x_velocity:          0.0138311386
y_velocity:          -0.660656929
z_velocity:          -3.48719978
x_acceleration:           0
y_acceleration:           0
z_acceleration:           0
health_flag_B:         0
rf_time_diff:          0
age_info:         0
sat_type:         1
P_flag:              0
accuracy_of_measurement:    1
health_flag_n:         0
**** ephemeris for GLONASS SV 2 ref time 02-Sep-2012 00:15:00 UTC period 30
freq_carrier_dev:      0
time_scale_shift:      0.000177043
x_coord:          2817.76367188
y_coord:          24919.2324219
z_coord:          -4698.22216797
x_velocity:          0.0138311386
y_velocity:          -0.660656929
z_velocity:          -3.48719978
x_acceleration:           0
y_acceleration:           0
z_acceleration:           0
```



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```
health_flag_B:         0
rf_time_diff:          0
age_info:         0
sat_type:         1
P_flag:              0
accuracy_of_measurement:    1
health_flag_n:         0
**** ephemeris for GLONASS SV 1 ref time 02-Sep-2012 00:45:00 UTC period 30
freq_carrier_dev:      0
time_scale_shift:      0.000177043
x_coord:          2538.734863281
y_coord:          23013.45605469
z_coord:          -10712.57324219
x_velocity:          -0.3560686111450
y_velocity:          -1.429982185364
z_velocity:          -3.152019500732
x_acceleration:           0
y_acceleration:           0
z_acceleration:           0
health_flag_B:         0
rf_time_diff:          0
age_info:         0
sat_type:         1
P_flag:              0
accuracy_of_measurement:    1
health_flag_n:         0
**** ephemeris for GLONASS SV 2 ref time 02-Sep-2012 00:45:00 UTC period 30
freq_carrier_dev:      0
time_scale_shift:      0.000177043
x_coord:          2538.734863281
y_coord:          23013.45605469
z_coord:          -10712.57324219
x_velocity:          -0.3560686111450
y_velocity:          -1.429982185364
z_velocity:          -3.152019500732
x_acceleration:           0
y_acceleration:           0
z_acceleration:           0
health_flag_B:         0
rf_time_diff:          0
age_info:         0
sat_type:         1
P_flag:              0
accuracy_of_measurement:    1
health_flag_n:         0
```

This table describes the parameters shown in the example file:

| Parameter | Record format |
|---|---|
| CUTOVER_RAMP_PERIOD: 60 | Should appear once at the start of the file.<br>Units are seconds, specifying the time period over which the satellite position transitions between the position specified by one dataset and the next, at the cutover between datasets. |


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| Parameter | Record format |
|---|---|
| **** ephemeris for GLONASS SV 1<br>ref time 02-Sep-2012 00:15:00 UTC<br>period 30 | Satellite record header<br>Specifies the reference time for this ephemeris set for this satellite, and the period (in minutes) over which it applies.<br>The reference time is in UTC, it specifies the middle of the period for which the ephemeris set applies. In this example, the ephemeris applies from 00:00:00 to 00:30:00 and the following set has a reference time of 00:45:00 and applies from 00:30:00 to 01:00:00.<br>The period may also take a value of 60, when the reference time is at the half-hour, and the data valid over the hour. For example, reference time 03:30:00, data valid from 03:00:00 to 04:00:00, next set reference time is 04:30:00.<br><br>You must set the period to be either 30 or 60 throughout the file. You cannot change this value during a simulation. |
| freq_carrier_dev: | gamma_n(tb) in reference e). |
| time_scale_shift: | tau_n in reference e). |
| x_coord:, y_coord:, z_coord:<br>x_velocity:, y_velocity:, z_velocity<br>x_acceleration:, y_acceleration:, z_acceleration: | Position, velocity and acceleration of the satellite in the three axes at the reference time.<br>Units: km, $km.s^{-1}$ and $km^{-2}$ (respectively) |
| health_flag_B: | B_n in reference e). 0: healthy, 1: unhealthy |
| rf_time_diff: | delta tau_n in reference e).<br>This is the time difference between the navigation RF signal transmitted in the L2 sub-band and the navigation signal transmitted in the L1 sub-band by satellite n<br>Units: seconds |
| age_info: | E_n in reference e).<br>This is the age of the immediate (ephemeris) information.<br>Units: days |
| ***Note**: The following fields are valid only for GLONASS-M satellites, but you must specify these fields for all GLONASS satellites* | |
| sat_type: | M (for Modification) in reference e).<br>0: older GLONASS satellite, 1: GLONASS-M satellite |
| P_flag: | P in reference e).<br>This indicates the mode of computation of frequency/time correction parameters.<br>If P is true, the data is computed by the satellites on board processor.<br>If P is false, the data is calculated at the control segment and uploaded to the satellite |
| accuracy_of_measurement: | F_T in reference e).<br>Range 0 to 15 (integer number only).<br>You must enter an integer in this range, rather than the accuracy in metres. For example, 11 represents a mean error of 64 metres, as in reference e). |
| health_flag_n: | l_n in reference e).<br>0: OK, 1: error |


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### 20.3.2 Ephemeris navigation data file

***Notes**:*

***1)** If you use **GLONASS-Ephemeris navigation data file**, you must ensure the Navigation Data is consistent with satellite motion.*

***2)** Enabling **GLONASS-Eph nav data file** and selecting an appropriate file also overrides settings in **Satellite orbital data file** (page 20-16).*

This file (**.eph_glo*) has the same format as **GLONASS-*Satellite orbital data file*** (page 20-16), including the position of the CUTOVER_RAMP_PERIOD keyword, although it has no effect in this context.

The information in each dataset defines the Navigation Data message for a satellite, for the time period you specify.

Generally, SimGEN reads the parameters in each dataset as floating or integer data, as relevant. After scaling, SimGEN inserts these parameters directly into the appropriate field of the Navigation Data message for the transmitting satellite.

### 20.3.3 Almanac navigation data file

***Notes**:*

***1)** If you use this file, you must ensure the Navigation Data is consistent with satellite motion*

***2)** If you omit this file, you cannot specify a GLONASS-**Almanac upload file** (page 20-22)*

This file (**.alm_glo*) defines the almanac data in the GLONASS Navigation Message. It is an ASCII file containing one dataset per satellite.

When using this file:

- The first line of each record (starting ***) defines the time of acquisition of the data. However, the initial almanac assignment applies from the start of the run.
- After scaling, SimGEN writes the data to the relevant almanac data fields in the GLONASS navigation data message.
- The almanac data you supply for a satellite is valid throughout the run unless superseded by a **GLONASS- *Almanac upload file*** (page 20-22).
- SimGEN uses the first set of the **GLONASS-*Ephemeris navigation data file*** (page 20-19), to generate an almanac data for each satellite not included in a GLONASS Almanac upload file. This applies if there is no GLONASS almanac data file.
- If you do not use user-defined ephemeris or almanac files, SimGEN generates almanac data using the orbital data and upload times you define in the GLONASS constellation file.

The format of each dataset is as follows:

```
**** almanac for GLONASS SV 3 upload time 01-Jan-2012 00:00:00 UTC ***********
day_number:          247
sat_conventional_number:       3
carrier_frequency:       -3
long_ascending_node:        0.7
time_of_node_passage:       12012.0
inclination_correction:        0.011
draconic_correction:        -2666.0
draconic_rate:         0.0
eccentricity:          0.0001
arg_perigee:        -0.17
sat_time_correction:        -0.0006
unhealthy_flag:           1
glonass_time_scale_correction:    0.0
tau_gps:            0.0
N_4:           5
flag_of_modification:       1
B1:            0.0
B2:            0.0
Kp:            2
```

This table describes the parameters shown in the example files:


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| Parameter | Record format |
|---|---|
| **** almanac for GLONASS SV 3 upload time 01-Jan-2012 00:00:00 UTC | Satellite record header<br>An almanac data set applies for a given GLONASS day. In this context, a day starts at Midnight Moscow UTC, three hours before UTC midnight (at the Greenwich meridian). Parameters day_number and N_4 number describe this day.<br>The upload time in the record header (this is UTC time, NOT Moscow time) is typically the start of the current GLONASS day, or sometime during that day. However, in this file, this almanac set is applied at the start of a simulation, irrespective of the upload time. It does however have an effect in **GLONASS-*Almanac upload file*** (page 20-22) |
| day_number: | The day number in a GLONASS 4-year period. The almanac data is referenced to the start of this day. |
| sat_conventional_number: | The satellite number/SV/SVID |
| carrier_frequency: | H_n number in reference e). |
| long_ascending_node: | lambda_n in reference e).<br>This is the longitude of the first ascending node of satellite n - in PZ90 co-ordinates<br>Units: semi-circles |
| time_of_node_passage: | t_lambda_n in reference e).<br>This is the time of the first ascending node passage of satellite n within day N.<br>Units: seconds |
| inclination_correction: | Delta_i_n in reference e).<br>This is the correction to the mean value of inclination of satellite n.<br>Units: semi-circles |
| draconic_correction: | Delta_T_n in reference e).<br>This is the correction to the mean value of inclination of satellite n.<br>Units: semi-circles |
| draconic_rate: | Delta_T_n_dot<br>This is the rate of change of the Draconian period of satellite n.<br>Units: seconds/(orbital period)$^2$ |
| eccentricity: | epsilon_n in reference e).<br>This is the eccentricity of satellite n.<br>Units: Dimensionless |
| arg_perigee: | omega_n in reference e).<br>This is the argument of perigee of satellite n.<br>Units: semi-circles |
| sat_time_correction: | tau_n in reference e).<br>This is the coarse value of satellite time correction to GLONASS time for satellite n.<br>Units: seconds |
| unhealthy_flag: | C_n in reference e).<br>This is the generalized unhealthy flag for satellite n. Satellite n is deemed inoperable if C_n = 0, and operable if the C-n = 1. |


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| Parameter | Record format |
|---|---|
| glonass_time_scale_correction: | tau_c in reference e).<br>This is the difference between the GLONASS system time and UTC time and is typically a very small value.<br>Range: ± 1 sec<br>Units : seconds |
| tau_gps: | tau_GPS<br>This is the correction (offset) to GPS time relative to GLONASS time.<br>Typically a very small number.<br>Range: ± 1.9 x $10^{-3}$<br>Units: seconds |
| N_4 | Number of 4-year period since start of GLONASS time, Jan 1st 1996, when **N_4** = 1 |
| flag_of_modification: | M_n in reference e). Indicates satellite type<br>0: GLONASS, 1: GLONASS-M |
| B1: | B1 in reference e).<br>This is the difference between UT1 and UTC(SU) at the beginning of the current day.<br>Range: ± 0.9<br>Units: seconds |
| **B2** | B2 in reference e).<br>This is the coefficient to determine UT1 and is equal to the daily change of difference in UT1 (expressed in seconds for a mean sun day)<br>Range: -4.5 to 3.5 x $10^{-3}$<br>Units seconds.$(msd)^{-1}$, |
| **Kp:** | KP in reference e).<br>This is the notification on forthcoming leap second correction of UTC and can take values:<br>0: No UTC correction at the end of current quarter<br>1: UTC correction of +1 s at the end of current quarter<br>2: UTC correction by - 1 s at the end of current quarter<br><br>***Note**: This value is only broadcast, it will not force a leap-second event in the simulation.* |


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### 20.3.4 Almanac upload file

***Note**: You must specify a **GLONASS-**Almanac navigation data file (page 20-19), before you can use an **Almanac upload file**.*

This file has the same format as ***GLONASS-**Almanac navigation data file (page 20-19)*.

For a given satellite, the first line of the almanac dataset (the upload time) defines the time at which this data begins to be broadcast. The data in the **GLONASS-***Almanac navigation data file* replaces almanac data the satellite was previously using.

You must correctly align the upload time for the almanac with a corresponding change in ephemeris/clock data for that satellite.


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# 21 Vehicle models

***Notes**:*

***1)** SimGEN version 2-50 onward allows control of certain vehicle types from a user generated motion file, rather than through the motion editors*

***2)** SimGEN version 2-82 onward places the aiding offset file in **INS error models-**Aiding offset (page 22-5)*

This chapter gives details on SimGEN's vehicle models, beginning with definitions of vehicle body axes and vehicle body attitude used by SimGEN.

SimGEN associates antennas with vehicles. For convenience, SimGEN numbers the vehicle and antenna, starting from one, so a simple scenario will use Vehicle 1, Antenna 1. If you add a second vehicle, SimGEN adds Vehicle 2 and automatically assigns Antenna 1 to Vehicle 2. You can label each antenna or vehicle using a right-click and selecting **Label**.

You cannot delete Vehicle 1, Antenna 1.

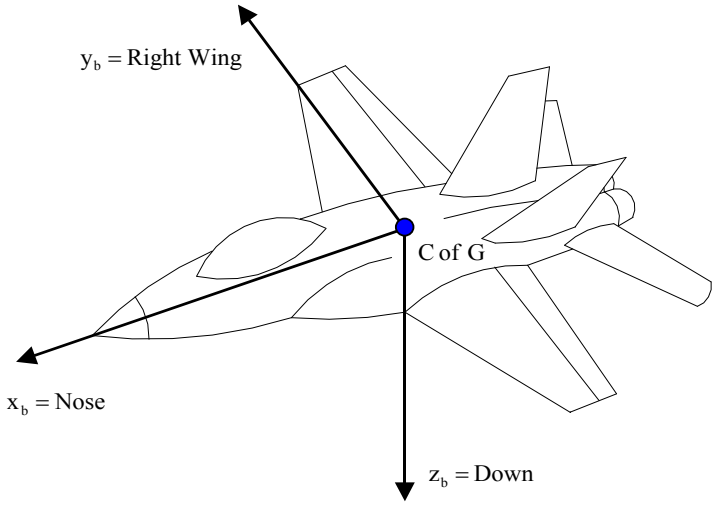
Reference ggg) gives more details on vehicle reference frames and motion handling.

## 21.1 Vehicle body axes

Vehicle body axes are defined at the vehicle's Centre of Gravity (CofG). This table describes aircraft body axes ($x_b$, $y_b$, $z_b$), with similar definitions for other vehicles.

| Axis | Description |
|---|---|
| $x_b$ | Pointing towards the nose (the nominal direction of travel) |
| $y_b$ | (Orthogonal to $x_b$ ) - pointing towards the starboard side (right wing) |
| $z_b$ | Nominally down |

The axes of an aircraft - similar definitions apply to other vehicle types:




## 21.2 Vehicle body attitude

Vehicle body attitude is defined with respect to the Local Geodetic frame.

Vehicle body attitude is a series of angular rotations in moving the body axes from alignment with the Local Geodetic reference frame (North, East, Down) to the current vehicle orientation. This table shows the sequence of generation of these angles (Euler angles).

| Rotation | Local Geodetic parameter | Direction of rotation |
|---|---|---|
| First | Heading ($\psi$) | About the vehicle $z_b$ axis |
| Second | Elevation ($\theta$) | About the new direction of the $y_b$ axis |


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| Rotation | Local Geodetic parameter | Direction of rotation |
|---|---|---|
| Third | Bank ($\phi$) | About the new direction of the $x_b$ axis |

Rotation conventions applied to an aircraft:

**Positive (+ve) bank or Roll**



**Positive (+) Elevation or Pitch**



**Positive (+) Heading or Yaw**



Where the vehicle uses Command and Personality files:

- → The Command file specifies a series of vehicle manoeuvres (for example turn left or turn right)
- → The Personality file defines the vehicle characteristics, which modify the performance of the manoeuvres (for example, defines the aircraft model to be an airliner or a fighter jet).

## 21.3 Vehicle models

This table details the vehicle types you can model with SimGEN. ***User*** motion files (page 21-38) give motion analogous to Remote Motion - see reference qq); but unlike remote motion, the user motion file remains associated with the scenario.

| Vehicle type | Vehicle type |
|---|---|
| ***Static model*** (page 21-4) | ***Ship*** (page 21-23) |
| ***Simple motion*** (page 21-5) | ***Spacecraft*** (page 21-29) |
| ***Aircraft*** (page 21-8) | ***Remote motion*** (page 21-37) |
| ***Land vehicle*** (page 21-19) | |


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If you are creating a new scenario, or changing the vehicle in an existing scenario, select the vehicle type you want to use by either using **Insert** to insert a new vehicle type (if you had one vehicle, selecting **Insert** creates a second vehicle),or using **Replace** to replace the existing vehicle. For example, to change the vehicle type:

- In the **Scenario Contents** window, select the appropriate **Vehicle**
- Click **New**
- Select the type of second vehicle you want to use, for example **aircraft**:




- Click **Replace**, to replace the current vehicle with your new choice
- You can choose to **Keep** the same antennas on the new vehicle, or to apply new antennas to the new vehicle. If you do not select **Keep** you must select new antennas, see **Receive and transmit antennas-*Adding / changing signal types at an antenna*** (page 23-5)
- Click **OK**

To rename the vehicle, right-click on **Vehicle**, click **Label** and type the vehicle name.

### 21.3.1 Add a second vehicle

To add a second vehicle to a scenario, follow these steps:

See the menu item **Options-*Change Hardware Configuration*** (page 5-18) and select an appropriate configuration

- In the **Scenario Contents** window, select <**scenario name**>**-Vehicle 1**
- Click **New**
- Select the type of second vehicle you want to use, for example – **aircraft**:

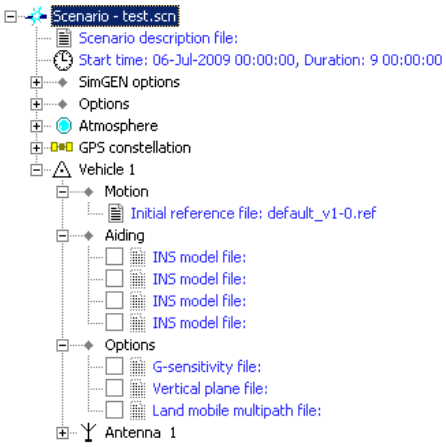



- Select **Insert**, to add a second vehicle to the scenario or **Replace** the current vehicle in the scenario with a new vehicle
- If you select **Replace**, you can choose to **Keep** the same antennas on the new vehicle, or to apply new antennas to the new vehicle
- Click **OK**
- Using a valid configuration, such as two GSS8000-series signal generators, SimGEN automatically maps the new antenna and vehicle to the signal generators.


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## 21.4 Static model

This vehicle model does not use motion. The following figure and the table detail the **Static vehicle** parameters.

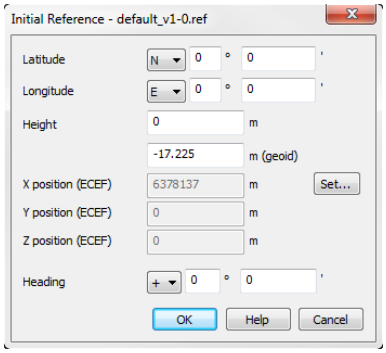



| Heading | Parameter |
|---|---|
| **Motion-** | ***Initial reference file*** |
| **Aiding-** | ***INS error model*** (page 22-1) |
| **Options-** | ***G sensitivity file*** (page 21-41) |
| | ***Vertical plane file*** (page 21-41) |
| | ***Land mobile multipath*** (page 21-58) |

### 21.4.1 Initial reference file

***Note**: Although the vehicle is static, if you use a non-isotropic receiver antenna pattern **Heading** will influence the satellite signals you receive.*

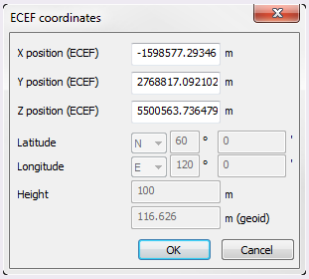
In the **Scenario contents** window, double-click **Motion-Initial reference file** to set the initial position of the vehicle using either **Latitude**, **Longitude** and **Height**, or ECEF coordinates. This file has the default name *default_vx-yy.ref*.




| | | | |
|---|---|---|---|
| **Latitude** | Units: degrees, minutes | | Range: N 90° 0’ to S 90° 0´ |
| **Longitude** | Units: degrees, minutes | | Range: E 180° 0.0´ to W 180° 0.0´ |
| **Height** | Type the vehicle height relative to either: the WGS ellipsoid or to the local geoid. Reference a) derives the relationship between local geoid and ellipsoid heights. These heights will vary with position. | | |
| | Units: metre | Range: -1 000 to 35 786 037.421 m | Default: 0 (-18 geoid) |


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Clicking **Set…** opens this dialog in which you can enter the reference location in **ECEF coordinates**:

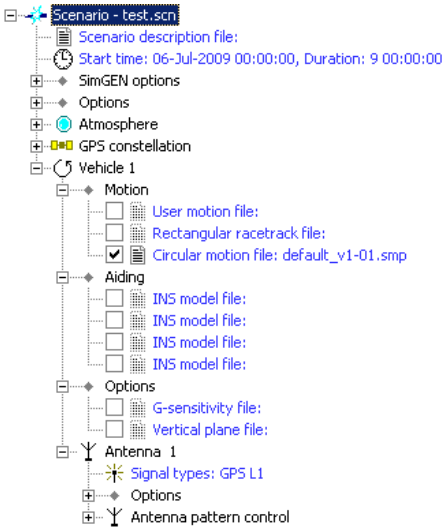



Notice **Latitude**, **Longitude** and **Height** update automatically as you move between the X, Y and Z positions.

| | | |
|---|---|---|
| **X position (ECEF), Y position (ECEF), Z position (ECEF)** | Units: metres | Range: -1E10 to 1E10 m |
| **Heading** | Type the direction of the vehicle in degrees and minutes. | |

## 21.5 Simple motion

**Simple motion** lets you select one of two motion models, **Rectangular racetrack** or **Circular motion**. The table details simple motion parameters.




| Parameter | Description |
|---|---|
| **Motion-** | ***User motion files*** (page 21-38) |
| | ***Circular motion*** (page 21-6) |
| | ***Rectangular racetrack*** (page 21-7) |
| **Aiding-** | ***INS error model*** (page 22-1) |
| **Options-** | ***G sensitivity file*** (page 21-41) |
| | ***Vertical plane file*** (page 21-41) |


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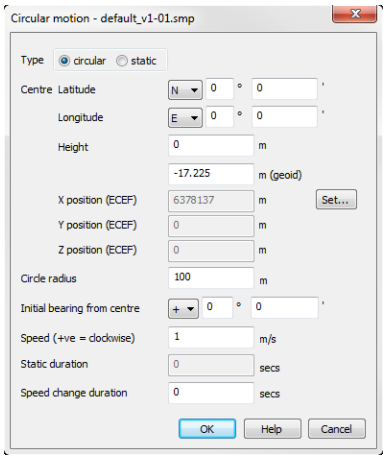
## 21.5.1 Circular motion

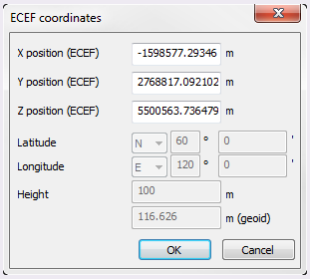
***Notes**:*

***1)** This model describes a perfect circle about a fixed point. The intention is that a mobile phone could perform this motion centred on a base station. This motion simulates phone dynamics for GPS navigation while maintaining a constant range to the base station.*

***2)** From SimGEN version 5.06 onwards, SimGEN treats **Circle Radius** as the distance from the **Centre** to the vehicle position along an arc modelling the curvature of the Earth.*

This model sets a mobile phone in circular motion about a base station. It maintains constant range (no Doppler) to the base station.




| | | | |
|---|---|---|---|
| **Type** | Choose from: circular (default) or static | | |
| **Centre** (of circular motion) | Type the location of the base station at the centre of the circle, you can use **Latitude**, **Longitude** and **Height**; or ECEF coordinates. | | |
| **Latitude** | Units: degrees, minutes | Range: N 90° 0’ to S 90° 0´ | |
| **Longitude** | Units: degrees, minutes | Range: E 180° 0.0´ to W 180° 0.0´ | |
| **Height** | Type the height of the centre of motion relative to either: the WGS ellipsoid or to the local geoid.<br>Reference a) derives the relationship between local geoid and ellipsoid heights. These heights will vary with position. | | |
| | Units: metre | Range: -1 000 to 1 E7 m | Default: 0<br>(-18 geoid) |
| Clicking **Set…** opens this dialog in which you can enter the reference location in **ECEF coordinates**:<br>  <br><br>Notice **Latitude**, **Longitude** and **Height** update automatically as you move between the X, Y and Z positions. | | | |
| **X position (ECEF)**, **Y position (ECEF)**, **Z position (ECEF)** | Units: metres | Range: -1E10 to 1E10 m | |
| **Circle radius** | Units: metre | Range: 1 to 1 500 000 m | Default: 100 |

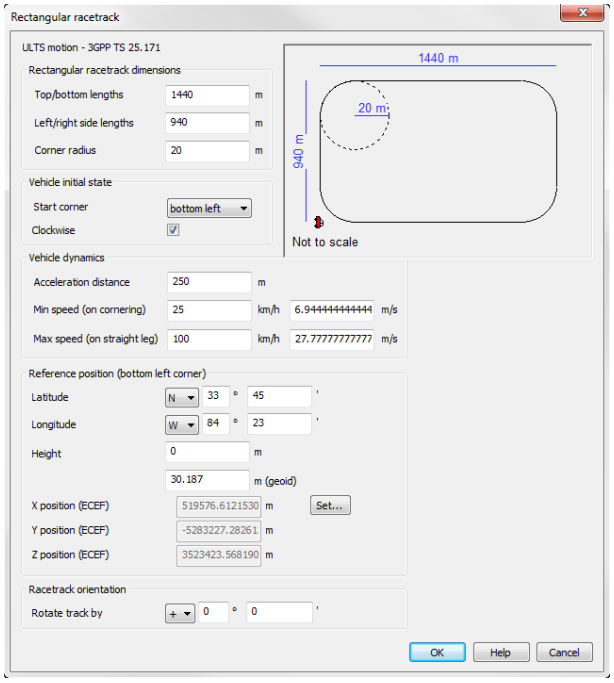

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| | | | |
|---|---|---|---|
| **Clockwise** | Select for clock wise motion (default)<br>Deselect for anti-clockwise motion | | |
| **Initial bearing from centre** | Type the bearing of the vehicle from the centre of the circle at the start of the scenario.<br>90° places the vehicle due East of the centre of the circle. | | |
| **Speed (+ve = clockwise)** | Units: metres per second | Range: 1 to 100 000 $m.s^{-1}$ | Default: 1 |
| **Static duration** | Units: seconds | Range: 1 to 32 400 s | Default: 0 |
| **Speed change duration** | Type the time over which you want to change the speed. Typing a value in this text box enables **Static duration**. | | |
| | Units: seconds | Range: 1 to 32 400 s | Default: 0 |

## 21.5.2 Rectangular racetrack

This model aids scenario generation for mobile phone testing. Although directly aimed at the 3GPP specification TS 25.171, a wider audience may use this model.

The figure below shows the parameters that configure the size and location of the racetrack and the corner radius. You can also set the vehicle dynamics.

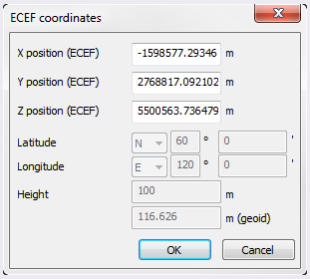



At the start of the scenario, the vehicle is travelling at the cornering velocity to ensure first lap dynamics are identical to all subsequent laps.

Once the scenario starts, the vehicle will traverse the track indefinitely.

| | | | |
|---|---|---|---|
| **Rectangular racetrack dimension** | | | |
| **Top/bottom lengths** | Units: metre | Range: 4 to 100 000 m | Default: 1440 |
| **Left / right side lengths** | Units: metre | Range: 4 to 100 000 m | Default: 940 |
| **Corner radius** | Units: metre | Range: 1 to 25 000 m | Default: 20 |
| **Vehicle initial state** | | | |
| **Start corner** | Select the start corner<br>Default: bottom left | | |


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| | | | |
|---|---|---|---|
| **Clockwise** | Select for clock wise motion (default)<br>Deselect for anti-clockwise motion | | |
| **Vehicle dynamics** | | | |
| **Acceleration distance** | Units: metre | Range: 1 to 25 000 m | Default: 250 |
| **Min speed (on cornering)** | Units: kilometres per hour | Range: 1 to 10 000 $km.h^{-1}$ | Default: 25 |
| **Min speed (on straight leg)** | Units: kilometres per hour | Range: 1 to 10 000 $km.h^{-1}$ | Default: 100 |
| **Reference position (bottom left-hand corner)** | Defines the bottom left-hand corner of the racetrack | | |
| **Latitude** | Units: degrees, minutes | Range: N 90° 0’ to S 90° 0´ | |
| **Longitude** | Units: degrees, minutes | Range: E 180° 0.0´ to W 180° 0.0´ | |
| **Height** | Type the vehicle height relative to either: the WGS ellipsoid or to the local geoid. Reference a) derives the relationship between local geoid and ellipsoid heights. These heights will vary with position. | | |
| | Units: metre | Range: -1 000 to +1 E7 m | Default: 0<br>(30.772 geoid) |
| Clicking **Set…** opens this dialog in which you can enter the reference location in **ECEF coordinates**:<br>  <br><br>Notice **Latitude**, **Longitude** and **Height** update automatically as you move between the X, Y and Z positions. | | | |
| **X position (ECEF),**<br>**Y position (ECEF),**<br>**Z position (ECEF)** | Units: metres | Range: -1E10 to 1E10 m | |
| **Racetrack orientation** | | | |
| **Rotate track by** | Type the rotation angle in degrees and minutes | | |

## 21.6 Aircraft

***Note**: From SimGEN 2-40 onwards, you can introduce a fixed angular offset, so the aircraft can roll, pitch or yaw to a given angle and stay in this mode until you counteract it. Enter this manoeuvre using the **Straight-Auxiliary** command.*
*Prior to this SimGEN executed “perfect” banked turns, with no sideslip.*

Rotation conventions applied to an aircraft:

**Positive (+ve) bank or Roll**




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**Positive (+) Elevation or Pitch**

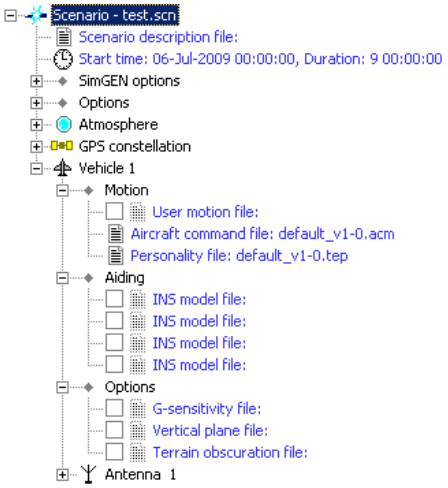


**Positive (+) Heading or Yaw**



The total duration of all commands may be longer or shorter than the scenario duration. If shorter, motion continues along the current trajectory after completion of the last command. If longer, the command list is truncated.

This figure and the following table detail the Aircraft parameters:




| Section | Description |
|---|---|
| **Motion-** | ***User motion files*** (page 21-38) |
| | ***Command file*** |
| | ***Personality file*** (page 21-17) |
| **Aiding-** | ***INS error model*** (page 22-1) |
| **Options-** | ***G sensitivity file*** (page 21-41) |
| | ***Vertical plane file*** (page 21-41) |


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| Section | Description |
|---|---|
| | ***Terrain obscuration file*** (page 21-65) |

### 21.6.1 Command file

***Notes***:

***1)*** *The maximum height for aircraft is 200 km. This height exceeds the maximum height of the Terrestrial Ionospheric model.*
*If your aircraft height is likely to exceed 80 km, Spirent recommends setting the* ***switched*** *parameter in* ***Atmosphere file-Ionospheric model*** *(page 9-2) and using an appropriate altitude*

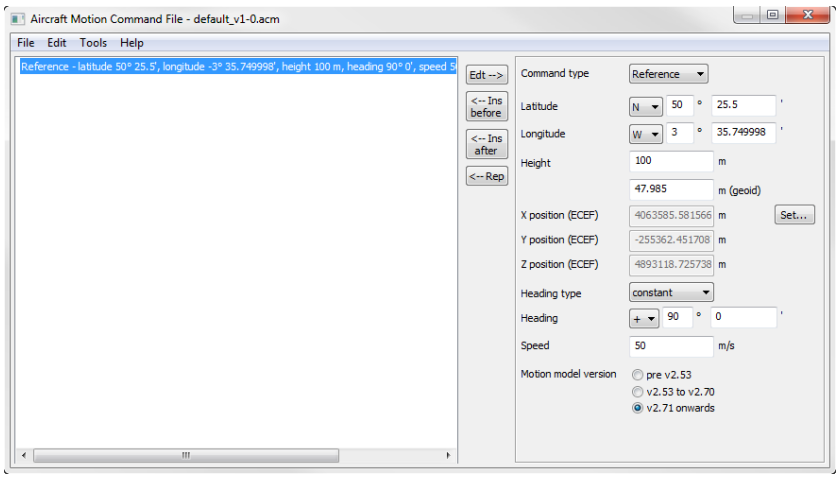
***2)*** *You must manually build the Command file list in the order you want. SimGEN does not automatically order these actions.*

The Command file for this model contains a list of manoeuvres. Each manoeuvre has an associated set of parameters. These parameters define the duration and dynamics of the manoeuvre. The total duration of all commands may be longer or shorter than the scenario duration. If shorter, motion continues along the current trajectory after completion of the last command. If longer, the command list is truncated.

The Aircraft command file is a sequence of manoeuvres. Each command (with the exception of the **Waypoint** command) is relative, not absolute (that is, use “turn 90°”, not “turn to a heading of 180°”). This allows you to insert or delete commands at any point in the sequence, within the model’s capability.

To edit the default Aircraft Command file, *default_vx-yy.acm:*

→ Select the file and double-click it to open the SimGEN ***List Editor*** (page 5-33):




→ Select the Command Type you want to add to the Command file.

→ Enter the parameters for the **Command Type** you selected. This table shows the supported command types.

| Command Type |
|---|
| ***Reference*** (page 21-11) |
| ***Accelerate*** (page 21-12) |
| ***Accel turn*** (page 21-12) |
| ***Climb*** (page 21-12) |
| ***Combined*** (page 21-13) |
| ***Halt*** (page 21-13) |
| ***Orbit*** (page 21-13) |
| ***Straight*** (page 21-13) |
| ***Straight - axial roll*** (page 21-14) |



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| Command Type |
|---|
| ***Straight - axial pitch*** (page 21-15) |
| ***Straight - axial yaw*** (page 21-15) |
| ***Turn*** (page 21-15) |
| ***Waypoint*** (page 21-16) |

***Vehicle body attitude*** (page 21-1) gives more detail on vehicle axes and attitudes.

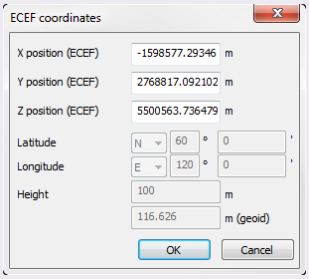
### 21.6.1.1 Reference

The first command in the list is always the **Reference** command. This command defines the vehicle's terrestrial position at the start of the simulated scenario and specifies the initial heading and speed (velocity). You can enter the reference position of the vehicle as Latitude, Longitude and Height, or as ECEF coordinates.

Two trajectories for each motion command are possible:

**Constant Heading -** keeps the vehicle heading on a constant compass bearing. Manoeuvres are only realistic when the vehicle is not in close proximity to either of the poles. As the vehicle approaches either North or South poles, an increasing angular velocity is required to maintain the specified heading. If the vehicle continues on a constant heading near to a pole, the angular velocity could exceed the dynamic capabilities of the vehicle. If the lateral acceleration for a constant heading trajectory exceeds 0.1 g, it cannot maintain the heading and must use the great circle trajectory.

**Great Circle -** overcomes the problems associated with constant heading at high latitudes. The direction is from the initial specified heading. The motion is along a great circle, defined by that direction.

| | | | |
|---|---|---|---|
| **Latitude** | Units: degrees, minutes | Range: N 90° 0.0´ to S 90° 0.0´ | |
| **Longitude** | Units: degrees, minutes | Range: E 180° 0.0´ to W 180° 0.0´ | |
| **Initial Height** | Units: metres | Range: -20 000 to 200 000 m | Default: 100 (49.464 geoid) |
| ***Note**: You can define the height as relative to the WGS-84 ellipsoid, or to the local geoid. The relationship between local geoid and ellipsoid heights derives from reference* a) *and varies depending on latitude and / or longitude.* | | | |
| Clicking **Set…** opens this dialog in which you can enter the reference location in **ECEF coordinates**:<br>  <br><br>Notice **Latitude**, **Longitude** and **Height** update automatically as you move between the X, Y and Z positions. | | | |
| **X position (ECEF),**<br>**Y position (ECEF),**<br>**Z position (ECEF)** | Units: metres | Range: -1E10 to 1E10 m | |
| **Heading** | Units: degrees, minutes | Range: -180.0° to 180.0° | |
| **Speed** | Units: metres per second | Range: 0.000 to 110 000 $m.s^{-1}$ | Default: 50 |
| **Heading Type** | Choose from: **Constant Heading** (default) or **Great Circle**. | | |


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| | |
|---|---|
| **Motion model version** | For backwards compatibility purposes, existing scenarios automatically select the appropriate motion model.<br><br>If you are creating a new scenario, you can choose the motion model you want to use from these SimGEN versions:<br>Pre v2.53<br>This model had very high accelerations and jerks (way beyond those specified in the personality limits) in an attempt at securing accuracy in achieving the specified motion.<br>v2.53 to v2.70<br>This model addressed the issue of very high accelerations and jerks; however, on occasions the motion was too subdued.<br>v2.71 onwards (default)<br>Where possible, this model ensures personality limits for accelerations are exercised at their limits. |

#### 21.6.1.2 Accelerate

Use this command to change the aircraft speed using a **speed change** (or **final speed**) and a **duration** (or **distance**) over which the speed changes. The vehicle maintains its heading and height throughout the manoeuvre.

| | | | |
|---|---|---|---|
| **Duration** | Units: seconds | Range: 0.0 to 32 400 s | Default: 100 |
| **Distance** | Units: metres | Range: 0 to 10 000 000 m | Default: 100 |
| **Speed Change** | Units: metres per second | Range: ±110 000.000m.s$^{-1}$ | Default: 10 |
| **Final Speed** | Units: metres per second | Range: 0 to 110 000.000 m.s$^{-1}$ | Default: 50 |

#### 21.6.1.3 Accel turn

This command changes the aircraft speed and heading using a speed change, change in heading or direction and a lateral acceleration (in the horizontal plane) that, in turn, determines the rate of change of heading or direction. The duration of the manoeuvre depends on the vehicle speed. During the manoeuvre, the aircraft performs the speed change once it has achieved the maximum bank angle allowed by the lateral acceleration.

The aircraft banks to achieve lateral acceleration.

In this configuration, there is no sideslip. The lift force is perpendicular to the longitudinal plane of the aircraft and Spirent assumes it passes through the centre of gravity. As the bank angle increases, the component of lift force in the horizontal plane also increases and the aircraft meets the specified lateral (horizontal) acceleration by banking to a given angle.

| | | | |
|---|---|---|---|
| **Heading Change** | Units: degrees, minutes | Range: ± 9 999.0° | |
| **Lateral Acceleration** | Units: g | Range: 0.001 to 30.0 g | Default: 1 |
| **Speed Change** | Units: metres per second | Range: ±110 000.000 m.s$^{-1}$ | Default: 10 |

#### 21.6.1.4 Climb

Use to change the height of the aircraft in terms of required height change, rate of change of height, and pitch acceleration at the start and end of the manoeuvre (you enter these pitch accelerations as lateral accelerations).

The manoeuvre assumes the aircraft is at zero incidence with the aircraft velocity vector aligned along the longitudinal axis (no sideslip). Therefore, the elevation of the aircraft relates directly to the climb rate. The rate at which the aircraft attains the required elevation angle is proportional to the specified start acceleration, and similarly the rate at which the aircraft resumes straight and level flight at the end of the manoeuvre is proportional to the specified end acceleration.

Select **Apply pitch offset** to offset the aircraft pitch relative to the ground.

Deselecting **Apply pitch offset** superimposes any pitch offset preceding the **Climb** command onto the velocity vector during the implementation phase of the **Climb** command.


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| | | | |
|---|---|---|---|
| **Height Change** | Units: metres | Range: Absolute height after manoeuvre must be in range: -20 000 to +200 000 m | |
| **Height rate** | Units: metres per second | Range: 0.100 to 10 000.0 $m.s^{-1}$ | Default: 20 |
| **Start lateral acc**.<br>The pitch acceleration at the start of the manoeuvre | Units: g | Range: 0.001 to 30.6 g | Default: 0.75 |
| **End lateral Acc.**<br>The pitch acceleration at the end of the manoeuvre | Units: g | Range: 0.001 to 30.6 g | Default: 1.5 |
| Select Apply pitch offset<br>to see<br>**Pitch Offset wrt ground** | Units: degrees | Range: 0.000 1 to +90° | Default: 5 |

#### 21.6.1.5 Combined

This command changes the speed, heading and height of the aircraft in distinct phases. Initially, it performs a constant speed turn and climb that will enable it to achieve the required heading and height upon completion of the manoeuvre. Next, while maintaining a constant elevation and heading, the aircraft accelerates to achieve the speed you specify. Finally, the manoeuvre terminates with a 'level out' phase, returning to zero elevation with the aircraft at the correct heading and height.

| | | | |
|---|---|---|---|
| **Heading change** | Units: degrees, minutes | Range: ± 9 999.0° | |
| **Lateral Acceleration** | Units: g | Range: 0.001 to 30.6 g | Default: 1.5 |
| **Height Change** | Units: metres | Range: Absolute height after manoeuvre must be in range: -20 000 to +200 000 m | Default: 100 |
| **Height Change Rate** | Units: metres per second | Range: 0.100 to 10 000 $m.s^{-1}$ | Default: 10 |
| **Speed change** | Units: metres per second | Range: ±110 000.000 $m.s^{-1}$ | Default: 10 |

#### 21.6.1.6 Halt

Stops (zero speed) the aircraft within the **duration** (or **distance**) you specify.

| | | | |
|---|---|---|---|
| **Duration** | Units: seconds | Range: 0 to 32 400.0 s | Default: 60 |
| **Distance** | Units: metres | Range: 0 to 10 000 000.0 m | Default: 50 |

#### 21.6.1.7 Orbit

**Orbit** is a special case of the **Combined** command. The aircraft performs an optimal accelerating climb to the required altitude and velocity.

| | | | |
|---|---|---|---|
| **Altitude** | Units: metres | Range: -2 000.0 to 10 000 000 m | Default:<br>200 000 |
| **Height Change Rate** | Units: metres per second | Range: 0 to 10 000.0 $m.s^{-1}$ | Default: 50 |

#### 21.6.1.8 Straight

Use for straight and level flight that you specify by a **Duration** (or **Distance**) and **Heading type**. Specify an **Auxiliary** command to insert a **roll**, **yaw** or **pitch** into the motion. You can only specify an **Auxiliary** command using **duration**; selecting **Distance** does not show the **Auxiliary** command.

| | | | |
|---|---|---|---|
| **Duration** | Unit: seconds | Range: 0.0 to 32 400 s | Default: 10 |


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| | | | |
|---|---|---|---|
| **Distance** | Units: metres | Range: 0.000 to 10 000 000.0 m | Default: 50 |
| **Heading type** | Choose from:<br>**Constant heading** or **Great circle**, see *Reference* (page 21-11) | | |
| **Auxiliary** Command type | Selecting none does not insert an additional command. Axial Roll, Axial Yaw and Axial Pitch apply rotations about the X, Z and Y body axes respectively.<br>SimGEN retains the residual attitude offset at the end of the auxiliary command for application in subsequent commands (of any type). The offsets may be applicable about all three axes simultaneously, or in the presence of angular dynamics from other commands. In such cases, SimGEN will apply the rotational offsets as fixed changes in attitude rather than a sequential set of rotations about the body axes. | | |

#### 21.6.1.9 Straight - axial roll

This command specifies an axial rotation about the body X-axis. This manoeuvre is not dynamically correct but may form part of a receiver test function.

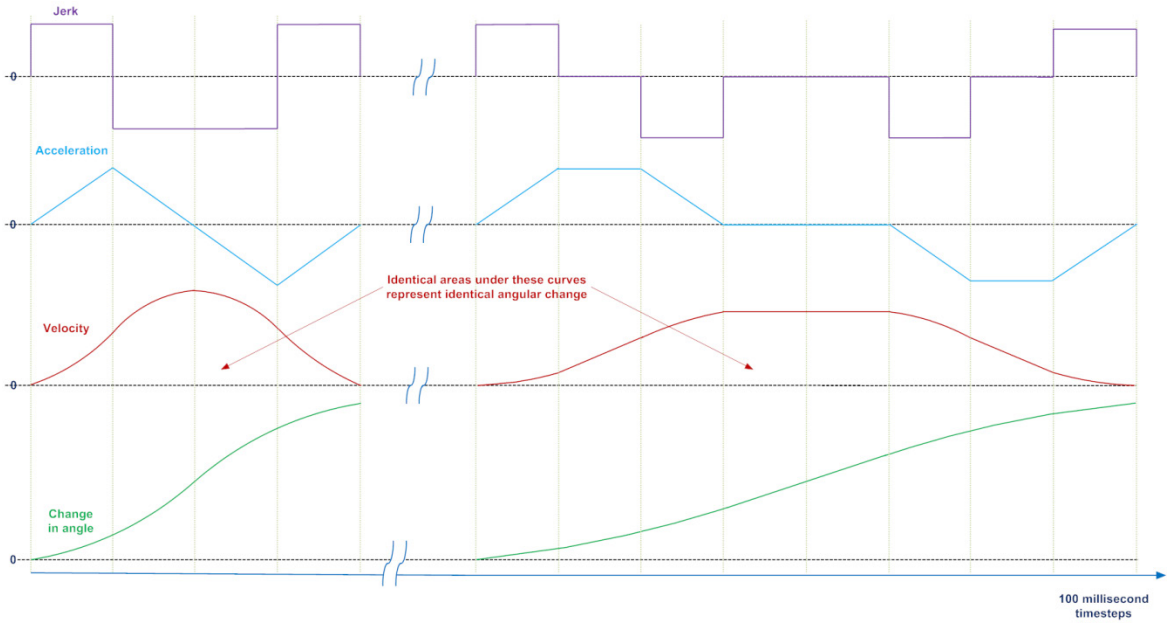
| | | | |
|---|---|---|---|
| **Rotation** | Units: degrees | Range: 0.0001° to 360 000° | Default: 0 |
| **Rate** | Units: degrees per second | Range: 0.0 to 400 °.s$^{-1}$<br>clockwise / anti-clockwise | Default: 0 |

##### 21.6.1.9.1 Limitations of axial roll

This motion command uses jerk to initiate and change motion, together with these limits:

- The parameters defined in the Personality file.
- SimGEN using a fixed, 100 millisecond, timestep resolution.
- SimGEN minimising quantisation errors introduced through using a fixed timestep.
- SimGEN using a minimum of four timesteps to achieve motion (that is the required angular change and angular rate).

These figures show examples of the jerk, acceleration, velocity and change in angle for the minimum four timesteps (left-hand side of figure) and for a longer duration (right-hand side of figure):




When you use the interface and enter values for the parameters **Duration**, **Rotation** and **Rate**, there will sometimes be apparent inconsistencies, with the interface displaying a **Rate** that must meet the SimGEN limits detailed above:


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- A **Rate** where the rate term is ramped slowly, reaches a peak and is then ramped down slowly.
- A **Rate** where the rate term is ramped as quickly as possible and then maintained as a constant

The second **Rate** is approximately twice the first **Rate**

For example:

1) You apply a ramp from zero to 75 degrees per second over a period of 0.2 seconds by:

- Over the first timestep (100 milliseconds), complete a positive jerk.
- Over the next timestep (100 milliseconds) complete a negative jerk.
- Over the third and fourth timesteps (100 milliseconds each) apply a ramp down from 75 degrees per second to zero.

This achieves a total offset of 15 degrees over a period of 0.4 seconds, achieving a maximum rate of 75 degrees per second at t = 0.2 seconds from start of command.

The area under the rate (velocity) curve represents the angular change.

2) If you now attempt to reduce the angular rate, SimGEN elongates the curve along the x-axis (time, in 100 millisecond steps) and reduces the y-axis (rate) to maintain the same angular change (in other words, SimGEN keeps the areas under each curve identical). For example, elongating the time axis by 100 milliseconds requires the maximum rate value to drop to 50 degrees per second to maintain the same area under the curve (maintains the angular change at 15 degrees).

If you need to use precise values of **Duration**, **Rotation** and **Rate**, Spirent recommends you first examine the way the **Rate** varies using values for the parameters **Duration** and **Rotation** that are close to the values you want to use.

To overcome any limitations when using these parameters, Spirent recommends you exactly specify the motion using a **.umt* file.

#### 21.6.1.10 Straight - axial pitch

This command specifies an axial rotation about the body Y-axis. This manoeuvre is not dynamically correct but may form part of a receiver test function.

| | | | |
|---|---|---|---|
| **Rotation** | Units: degrees | Range: 0.0001° to 360 000° | Default: 0 |
| **Rate** | Units: degrees per second | Range: 0.0 to 400 °.$s^{-1}$ clockwise / anti-clockwise | Default: 0 |

***Limitations of axial roll*** page 21-14, also apply to axial pitch.

#### 21.6.1.11 Straight - axial yaw

This command specifies an axial rotation about the body Z-axis. This manoeuvre is not dynamically correct but may form part of a receiver test function.

| | | | |
|---|---|---|---|
| **Rotation** | Units: degrees | Range: 0.0001° to 360 000° | Default: 0 |
| **Rate** | Units: degrees per second | Range: 0.0 to 400 °.$s^{-1}$ clockwise / anti-clockwise | Default: 0 |

***Limitations of axial roll*** page 21-14, also apply to axial yaw.

#### 21.6.1.12 Turn

This command changes the aircraft heading with a change in heading or direction and a lateral acceleration (in the horizontal plane) that, in turn, determines the rate of change of heading or direction. The duration of the manoeuvre depends on the aircraft speed during the manoeuvre; the manoeuvre maintains angular speed throughout the turn.


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The aircraft banks to achieve lateral acceleration. In this configuration, there is no sideslip. The lift force is perpendicular to the longitudinal plane of the aircraft, Spirent assume it passes through its centre of gravity. As the bank angle increases, the component of lift force in the horizontal plane also increases. The aircraft meets the lateral (horizontal) acceleration you specify by banking to a given angle.

| | | | |
|---|---|---|---|
| **Heading change** | Units: degrees, minutes | Range: ± 9 999.0° | |
| **Lateral Acceleration** | Units: g | Range: 0.001 to 30.6 g | Default: 1 |

#### 21.6.1.13 Waypoint

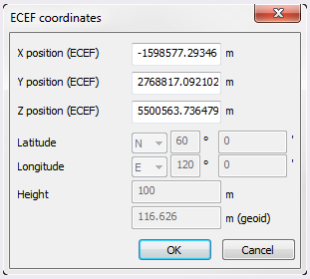
Specifies waypoints in terms of **Latitude**, **Longitude** and **Height** and represents a position to which the vehicle is to move at its current speed. Lateral acceleration is required to perform any turn with the vehicle banking to a given angle to meet the specified lateral acceleration.

**Waypoint** performs a **Turn** (minimising the heading error) and when pointing towards the waypoint, it performs a **Climb**. If there is no change in height, the trajectory will carry on straight and level until it is near the waypoint (the position size error is less than 0.5*speed*simulation_time_step_size).

SimGEN checks that stress from jerks and accelerations experienced during the motion are within the limits set in the ***Personality file*** (page 21-17). **Waypoint** tries to keep the motion within the constraints specified, as well as within the Personality file.

Spirent implements **Waypoint** to minimise the positional error between the target and the achievable, simulated position. This could mean the applied lateral accelerations are different to those you have specified. If the lateral accelerations are different, the **System messages** window warns you.

Selecting the menu item **Options-*Message Reporting*-Display-Debug** (page 5-26) sets the **System messages** window to show positional errors at the end of the **Waypoint** command.

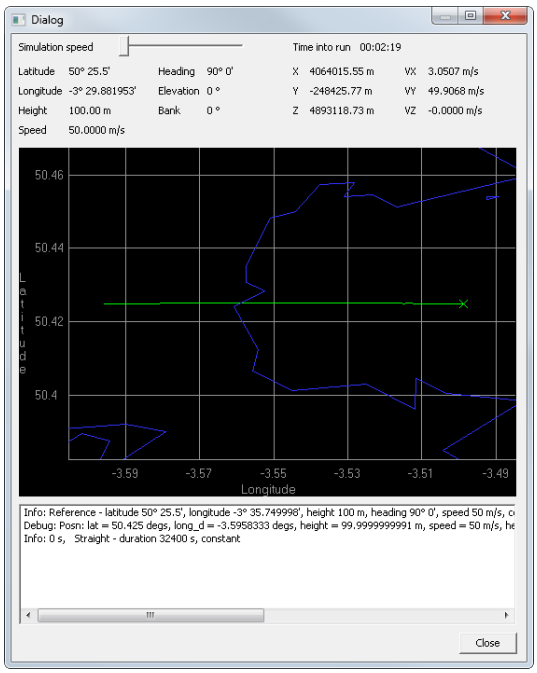
| | | | |
|---|---|---|---|
| **Latitude** | Units: degrees, minutes | Range: N 90° 0’ to S 90° 0´ | |
| **Longitude** | Units: degrees, minutes | Range: E 180° 0.0´ to W 180° 0.0´ | |
| **Height** | Units: metres | Range: -20 000 m to 200 000 m | Default: 100 |
| Clicking **Set…** opens this dialog in which you can enter the reference location in **ECEF coordinates**:<br>  <br><br>Notice **Latitude**, **Longitude** and **Height** update automatically as you move between the X, Y and Z positions. | | | |
| **X position (ECEF), Y position (ECEF), Z position (ECEF)** | Units: metres | Range: -1E10 to 1E10 m | |
| **Lateral Acceleration** | Units: g | Range: 0.001 to 30.6 g | Default: 1.5 |

### 21.6.2 Check all utility

***Note**: **Simulation speed** sets the speed of the internal timer and affects the workload of the SimGEN Controller processor.*

Check the validity of the motion trajectory you want to use by selecting **Aircraft Motion Command File-Tools-Check all**. Simulation of the motion trajectory begins immediately. You can set the simulation speed using the **Simulation speed** slider. The area below the map shows information on the simulation:


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The **Check all** utility tests for the integrity of the motion trajectory in the Aircraft Command file by running the same motion model, but running faster than real-time.

The **Check all** utility crosschecks the commands in the Command file against the maximum limits held in the Personality file. Motion is in accordance with the Command file, just as if the motion was running in real-time.

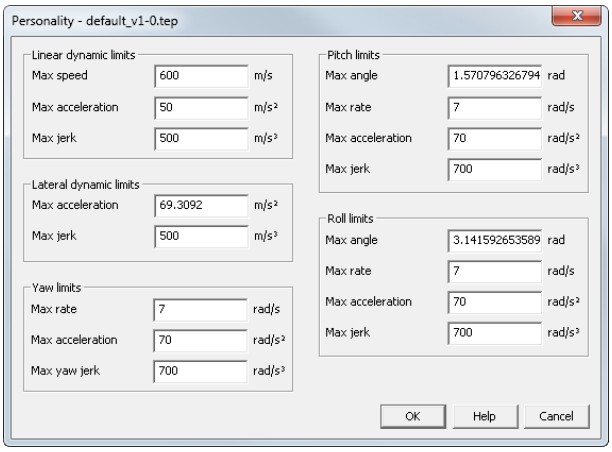
The map plots ground track at every one-second epoch of the simulation.

### 21.6.3 Personality file

This file specifies the aircraft characteristics the simulation will use. The default filename is *default_vx-yy.tep*. The aircraft characteristics modify the manoeuvres specified in the ***Command file*** (page 21-10). For example, specifying a slow roll-rate in the Personality file means the aircraft will take longer to roll to the required bank angle for a turn, so modifying the duration and radius of the turn. Use the Personality file to make the aircraft behave like an airliner or a fast responsive fighter.

To edit the default Personality file:

→ Select the file and double-click it, the editor opens,




→ Enter the new data. This table details the parameters:

| Personality file parameter |
|---|
| ***Linear dynamics*** (page 21-18) |
| ***Lateral dynamics*** (page 21-18) |
| ***Yaw limits*** (page 21-18) |


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| Personality file parameter |
|---|
| ***Pitch limits*** (page 21-18) |
| ***Roll limits*** (page 21-19) |

#### 21.6.3.1 Linear dynamics

| | | | |
|---|---|---|---|
| **Max Speed**<br>Maximum linear velocity | Units: metres per second | Range: 0 to 110 000.00 $m.s^{-1}$ | Default: 600 |
| **Max Acceleration**<br>Maximum linear acceleration | Units: metres per $(second)^2$ | Range: 0.01 to 450.00 $m.s^{-2}$ | Default: 50 |
| **Max Jerk**<br>Maximum rate of change of linear acceleration | Units: metres per $(second)^3$ | Range: 0.01 $m.s^{-3}$ to 500.00 $m.s^{-3}$ | Default: 500 |

#### 21.6.3.2 Lateral dynamics

| | | | |
|---|---|---|---|
| **Max Acceleration**<br>Maximum vehicle structural stress acceleration (corresponds to the positive ‘g’ stress normally quoted, but Spirent uses $m.s^{-2}$, not ‘g’). | Units: metres per $(second)^2$ | Range: 0.01 to 300.000 0 $m.s^{-2}$ | Default: 69.3092 |
| **Max Jerk**<br>Maximum rate of change of vehicle structural stress acceleration | Units: metres per $(second)^3$ | Range: 0.01 $m.s^{-3}$<br>to 500.000 0 $m.s^{-3}$ | Default: 500 |

#### 21.6.3.3 Yaw limits

| | | | |
|---|---|---|---|
| **Max Rate**<br>Maximum rate of rotation around the vehicle's vertical axis, (or simply, maximum rate of change of heading) | Units: radians per second | Range: 0.001 to 7 $rad.s^{-1}$ | Default: 7 |
| **Max Acceleration**<br>Maximum vehicle structural stress acceleration (corresponds to the positive ‘g’ stress normally quoted, but Spirent uses $m.s^{-2}$, not ‘g’). | Units: radians per $(second)^2$ | Range: 0.001 to 70 $rad.s^{-2}$ | Default: 70 |
| **Max Jerk**<br>Maximum rate of change of vehicle structural stress acceleration | Units: radians per $(second)^3$ | Range: 0.001 to 700 $rad.s^{-3}$ | Default: 700 |

#### 21.6.3.4 Pitch limits

| | | | |
|---|---|---|---|
| **Max Angle**<br>Maximum vehicle elevation (pitch) | Units: radians | Range: 0 to π/2 rad,<br>to 15 SF (0° to 90°) | Default: 90 |
| **Max Rate**<br>Maximum rate of change of vehicle elevation angle | Units: radians per second | Range: 0.001 to 7 $rad.s^{-1}$ | Default: 7 |
| **Max Acceleration**<br>Maximum acceleration in vehicle pitch angle | Units: radians per $(second)^2$ | Range: 0.001 to 70.0 $rad.s^{-2}$ | Default: 70 |
| **Max Jerk**<br>Maximum rate of change of acceleration in vehicle pitch angle | Units: radians per $(second)^3$ | Range: 0.001 to 700 $rad.s^{-3}$ | Default: 700 |


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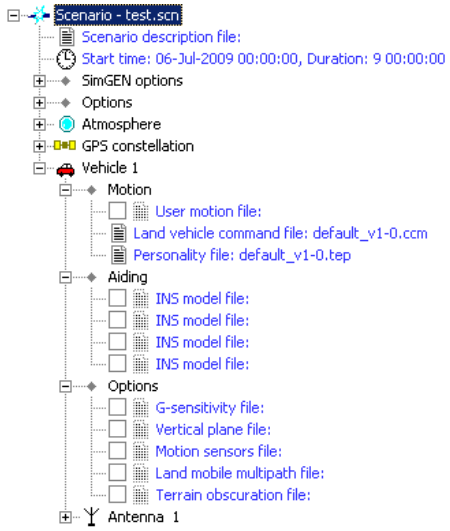
### 21.6.3.5 Roll limits

| | | | |
|---|---|---|---|
| **Max Angle**<br>Maximum vehicle bank angle | Units: radians | Range: 0 to π rad to 15 SF<br>(0° to 180°) | Default: 180<br>(360°) |
| **Max Rate**<br>Maximum roll-rate, the rate of change of bank angle | Units: radians per second | Range: 0.001 to 7 $rad.s^{-1}$ | Default: 7 |
| **Max Acceleration**<br>Maximum acceleration in bank angle | Units: radians per $(second)^2$ | Range: 0.001 to 70.0 $rad.s^{-2}$ | Default: 70 |
| **Max Jerk**<br>Maximum rate of change of acceleration in bank angle | Units: radians per $(second)^3$ | Range: 0.001 to 700 $rad.s^{-3}$ | Default: 700 |

## 21.7 Land vehicle

The total duration of all commands may be longer or shorter than the scenario duration. If shorter, motion continues along the current trajectory after completion of the last command. If longer, the command list is truncated.

This figure and the following table detail the Land vehicle parameters.




| Section | Description |
|---|---|
| **Motion-** | ***User motion files*** (page 21-38) |
| | ***Command file*** |
| | ***Personality file*** (page 21-23) |
| **Aiding-** | ***INS error model*** (page 22-1) |
| **Options-** | ***G sensitivity file*** (page 21-41) |
| | ***Vertical plane file*** (page 21-41) |
| | ***Motion sensors file (SimAUTO)*** (page 21-41) |
| | ***Land mobile multipath*** (page 21-58) |
| | ***Terrain obscuration file*** (page 21-65) |

### 21.7.1 Command file

***Note***: *You must manually build the Command file list in the order you want. SimGEN does not automatically order these actions.*

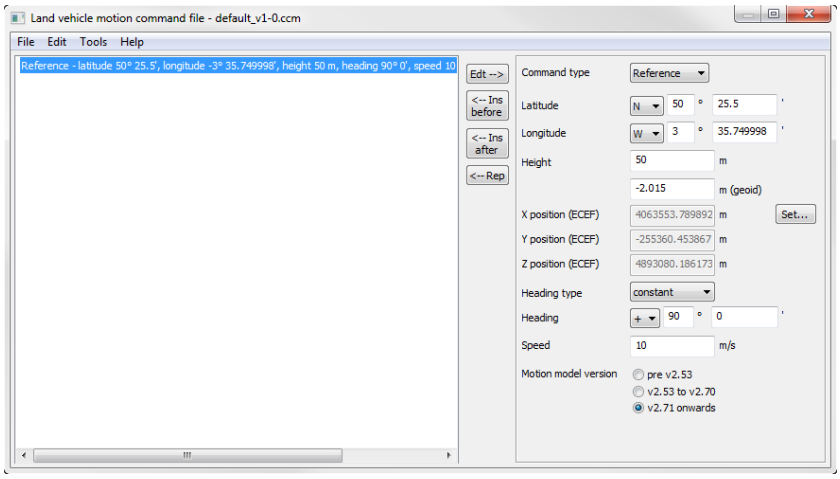

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The Command file for this model contains a list of manoeuvres. Each manoeuvre has an associated set of parameters. These parameters define the duration and dynamics of the manoeuvre. The total duration of all commands may be longer or shorter than the scenario duration. If shorter, motion continues along the current trajectory after completion of the last command. If longer, the command list is truncated.

The Land vehicle command file is a sequence of manoeuvres. Each command, with the exception of **Waypoint**, is relative, not absolute (use “turn through 90°”, not “turn to a heading of 180°”) allowing commands to be inserted or deleted at any point in the sequence, within the model’s capability.

To edit the default Land vehicle Command file, *default_vx-yy.ccm*:

→ Select the file and double-click it to open the SimGEN ***List Editor***:




→ Select the **Command Type** you want to add to the Command file.

→ Enter the parameters for the **Command Type** you selected. This table shows the supported command types:

| Command Type |
|---|
| ***Reference*** (page 21-20) |
| ***Acceleration*** (page 21-21) |
| ***Climb*** (page 21-21) |
| ***Halt*** (page 21-22) |
| ***Straight*** (page 21-22) |
| ***Turn*** (page 21-22) |
| ***Waypoint*** (page 21-23) |

### 21.7.1.1 Reference

The first command in the list is always the **Reference** command. This command defines the vehicle's terrestrial position at the start of the simulated scenario and specifies the initial heading and speed (velocity). You can enter the reference position of the vehicle as Latitude, Longitude and Height, or as ECEF coordinates.

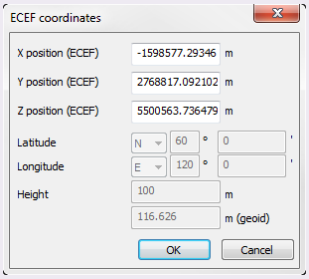
Two trajectories for each motion command are possible:

**Constant Heading -** keeps the vehicle heading on a constant compass bearing. Manoeuvres are only realistic when the vehicle is not in close proximity to either of the poles.

**Great Circle -** overcomes the problems associated with constant heading at high latitudes. The direction is from the initial specified heading. The motion is along a great circle, defined by that direction.

| | | |
|---|---|---|
| **Latitude** | Units: degrees, minutes | Range: N 90° 0.0´ to S 90° 0.0´ |
| **Longitude** | Units: degrees, minutes | Range: E 180° 0.0´ to W 180° 0.0´ |
| **Height** | Units: metres | Range: -10 000 to 30 000 m |


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| |
|---|
| ***Note**: You can define **Height** as relative to the WGS-84 ellipsoid, or to the local geoid. The relationship between local geoid and ellipsoid heights derives from reference a) and varies depending on latitude and / or longitude.* |
| Clicking **Set…** opens this dialog in which you can enter the reference location in **ECEF coordinates**:<br>  <br><br>Notice **Latitude**, **Longitude** and **Height** update automatically as you move between the X, Y and Z positions. |

| | | |
|---|---|---|
| **X position (ECEF),**<br>**Y position (ECEF),**<br>**Z position (ECEF)** | Units: metres | Range: -1E10 to 1E10 m |
| **Heading Type** | Choose from **Constant Heading** (default) or **Great Circle**. | |
| **Heading** | Units: degrees, minutes | |
| **Speed** | Units: metres per second | Range: ±110 000.000 $m.s^{-1}$ |
| ***Note**: Negative speed indicates the vehicle is moving in a reverse direction.* | | |
| **Motion model version** | For backwards compatibility purposes, existing scenarios automatically select the appropriate motion model.<br><br>If you are creating a new scenario, you can choose the motion model you want to use from these SimGEN versions:<br>Pre v2.53<br>This model had very high accelerations and jerks (way beyond those specified in the personality limits) in an attempt at securing accuracy in achieving the specified motion.<br>v2.53 to v2.70<br>This model addressed the issue of very high accelerations and jerks; however, on occasions the motion was too subdued.<br>v2.71 onwards (default)<br>Where possible, this model ensures personality limits for accelerations are exercised at their limits. | |

### 21.7.1.2 Acceleration

This command changes the speed of the Land vehicle. You specify a **speed change** (or **final speed**) and a **duration** (or **distance**) over which the speed changes.

The Land vehicle maintains its heading and height throughout the manoeuvre.

| | | | |
|---|---|---|---|
| **Duration** | Units: seconds | Range: 0.0 to 32 400 s | Default: 100 |
| **Distance** | Units: metres | Range: 0.000 to 10 000 000 m | Default: 100 |
| **Speed Change** | Units: metres per second | Range: ±110 000.000 $m.s^{-1}$ | Default: 10 |
| **Final Speed** | Units: metres per second | Range: 0 to 110 000.000 $m.s^{-1}$ | Default: 50 |

### 21.7.1.3 Climb

This command changes the height of the Land vehicle. You specify the **final height** or a **height change**, and the distance over which you want to change the height.


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| | | | |
|---|---|---|---|
| **final height** | Units: metres | Range: -10 000.000 to 30 000 m | Default: 100 |
| **height change** | Units: metres | Range: ±40 000.000 m | Default: 10 |
| **Distance** | Units: metres | Range: 0.000 to 20 000 m | Default: 100 |
| **Smoothing** | A value of 0.0 results in the maximum gradient during the climb manoeuvre. This is equal to the ratio of height to distance and results in large jerk values at the start and end of the climb.<br>A value of 1.0 results in lower jerk at the start and end by allowing the maximum gradient to be double the notional gradient. | | |
| | Units: none | Range: 0.000 to 1.0<br>Where<br>0 least smooth<br>1 most smooth | Default: 1 |

#### 21.7.1.4 Halt

Stops (zero speed) the Land vehicle within the **duration** (or **distance**) you specify.

| | | | |
|---|---|---|---|
| **Duration** | Unit: seconds | Range: 0 to 32 400.0 s | Default: 60 |
| **Distance** | Units: metres | Range: 0 to 10 000 000.0 m | Default: 50 |

#### 21.7.1.5 Straight

Use when a straight and level trajectory is required. You specify a **Distance** (or a **Duration**) and **Heading type**.

| | | | |
|---|---|---|---|
| **Duration** | Unit: seconds | Range: 0.0 to 32 400 s | Default: 10 |
| **Distance** | Units: metres | Range: 0.000 to 10 000 000.0 m | Default: 50 |
| **Heading type** | Choose from:<br>Constant heading or Great circle, see ***Reference*** (page 21-20) | | |

#### 21.7.1.6 Turn and acceleration during a turn

***Notes**:*

***1) Reference-Motion model version-v2.71 onwards** supports the **Final speed**, or **Speed change**, you specify while performing a **heading change** at a constant **turn radius** (acceleration during a turn).*
*It also supports acceleration during a turn while moving in the forward or reverse directions as well as when changing from forward to reverse motion and from reverse to forward motion.*

***2) Reference-Motion model version-v2.53 to v2.70** and **-Pre v2.53** will not implement speed changes and you will see a warning in the **System messages** window.*

***3)** You must use a non-zero vehicle speed to make a **heading change** during a turn, whereas the initial vehicle speed can be zero before applying acceleration during a turn.*

Use this command to change the heading of the Land vehicle using a **heading** (or **heading change**) and the **Turn radius**. The Land vehicle maintains the angular speed throughout the turn, except at the start and end of the turn commands when jerk and accelerations are active.

SimGEN implements angular changes of exactly 180 degrees as a turn to the right and always performs turns to a new heading over the smallest angular change. For example, a heading change from 0 degrees to 270 degrees results in a turn to the left.

To force a right-hand turn, you can either split the command into two consecutive turns, each with an angular change of less than 180 degrees (say 100 degrees and 170 degrees in the 270-degree example). Alternatively, select **Heading/change-heading change** and type a value in **Heading**. A negative **heading change** gives an anti-clockwise turn and a positive **heading change** gives a clockwise turn.

| | | | |
|---|---|---|---|
| **Turn radius** | Units: metres | Range: 0.001 to 5 000 m | Default: 10 |



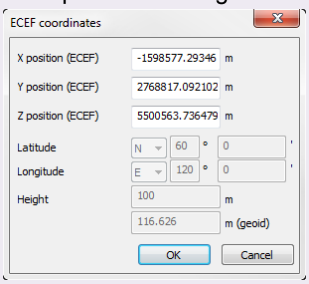
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| | | | |
|---|---|---|---|
| **Heading/change** | | | |
| **heading** | Units: degrees, minutes | Range: -180.000 to +180.000° (negative is anti-clockwise, positive is clockwise) | Default: 60 |
| **heading change** | Units: degrees, minutes | Range: ± 9 999.0° | Default: 60 |
| **Speed/change** | | | |
| **Final speed** | Units: metres per second | Range: ± 0.001 to 110 000 $m.s^{-1}$ | Default: 100 |
| **Speed change** | Units: metres per second | Range: ± 0.001 to 110 000 $m.s^{-1}$ | Default: 10 |

#### 21.7.1.7 Waypoint

You can specify Waypoints either in terms of **Latitude**, **Longitude** and **Height**, or in **ECEF coordinates**. They represent a position to which the Land vehicle is heading at its current speed.

SimGEN checks that stress from jerks and accelerations experienced during the motion are within the limits set in the ***Personality file*** (page 21-23). **Waypoint** tries to keep the motion within the constraints specified, as well as within the Personality file.

| | | | |
|---|---|---|---|
| **Latitude** | Units: degrees, minutes | Range: N 90° 0’ to S 90° 0´ | |
| **Longitude** | Units: degrees, minutes | Range: E 180° 0.0´ to W 180° 0.0´ | |
| **Height** | Units: metres | Range: -10 000 to 30 000 m | Default: 100 (115 geoid) |
| Clicking **Set…** opens this dialog in which you can enter the reference location in **ECEF coordinates**:<br>  <br><br>Notice **Latitude**, **Longitude** and **Height** update automatically as you move between the X, Y and Z positions. | | | |
| **X position (ECEF), Y position (ECEF), Z position (ECEF)** | Units: metres | Range: -1E10 to 1E10 m | |
| **Turn radius** | Units: metres | Range: 0.001 to 5 000 m | Default: 10 |

### 21.7.2 Personality file

This file specifies the Land vehicle characteristics the simulation will use. The default filename is *default_vx-yy.tep*. The Personality file modifies the manoeuvres you specify in the ***Command file*** (page 21-19). Use the Personality file to make the Land vehicle behave like a heavy vehicle or a sports car.

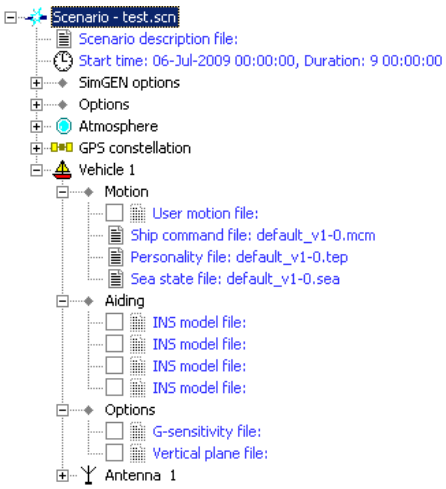
Edit the Land vehicle Personality file, *default_vx-yy.tep*, in the same way as the **Aircraft-*Personality file*** (page 21-17).

## 21.8 Ship

The total duration of all commands may be longer or shorter than the scenario duration. If shorter, motion continues along the current trajectory after completion of the last command. If longer, the command list is truncated.


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This figure and the following table detail the Ship parameters.




| Section | Description |
|---|---|
| **Motion-** | ***User motion files*** (page 21-38) |
| | ***Command file*** |
| | ***Personality file*** (page 21-27) |
| | ***Sea-state file*** (page 21-28) |
| **Aiding-** | ***INS error model*** (page 22-1) |
| **Options-** | ***G sensitivity file*** (page 21-41) |
| | ***Vertical plane file*** (page 21-41) |

## 21.8.1 Command file

***Note***: *You must manually build the Command file list in the order you want. SimGEN does not automatically order these actions.*

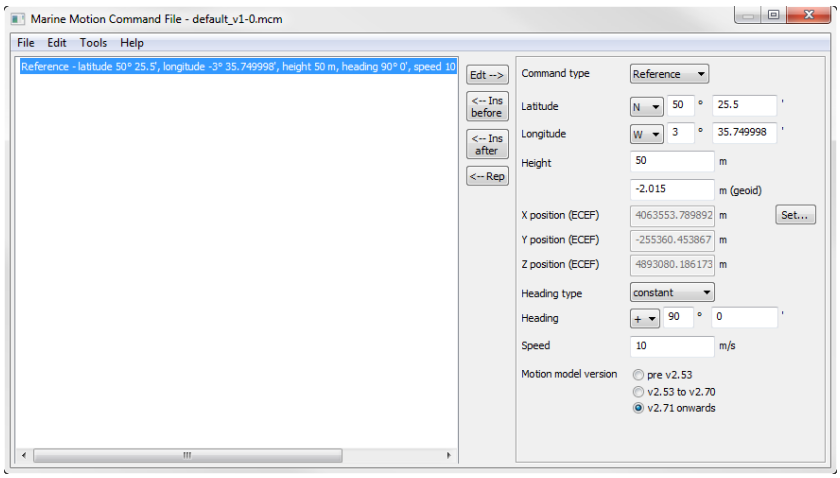
The Command file for this model contains a list of manoeuvres. Each manoeuvre has an associated set of parameters. These parameters define the duration and dynamics of the manoeuvre. The total duration of all commands may be longer or shorter than the scenario duration. If shorter, motion continues along the current trajectory after completion of the last command. If longer, the command list is truncated.

Each command in the Ship command file, with the exception of **Waypoint**, is relative, not absolute (use “turn through 90°”, not “turn to a heading of 180°”). This lets you insert or delete commands at any point in the sequence, within the model’s capability.

To edit the default Ship Command file, *default_vx-yy.mcm*:

→ Select the file and double-click it to open the SimGEN ***List Editor*** (page 5-33):


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→ Select the **Command Type** you want to add to the Command file.

→ Enter the parameters for the **Command Type** you selected. This table shows the supported command types:

| Command Type |
|---|
| ***Reference*** (page 21-25) |
| ***Accelerate*** (page 21-26) |
| ***Halt*** (page 21-26) |
| ***Straight*** (page 21-27) |
| ***Turn*** (page 21-27) |
| ***Waypoint*** (page 21-27) |

### 21.8.1.1 Reference

The first command in the list is always the **Reference** command. This command defines the vehicle's terrestrial position at the start of the simulated scenario and specifies the initial heading and speed (velocity).

Two trajectories for each motion command are possible:

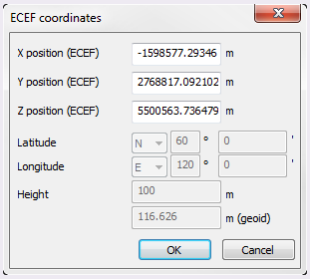
**Constant Heading -** keeps the vehicle heading on a constant compass bearing. Manoeuvres are only realistic when the vehicle is not in close proximity to either of the poles. As the vehicle approaches either pole, an increasing angular velocity is required to maintain the specified heading. If the vehicle continues on a constant heading near a pole, the angular velocity could exceed the dynamic capabilities of the vehicle.

**Great Circle -** overcomes the problems associated with constant heading at high latitudes. The direction is from the initial specified heading. The motion is along a great circle, defined by that direction.

| | | | |
|---|---|---|---|
| **Latitude** | Units: degrees, minutes | Range: N 90° 0.0´ to S 90° 0.0´ | |
| **Longitude** | Units: degrees, minutes | Range: E 180° 0.0´ to W 180° 0.0´ | |
| **Height** | Units: metres | Range: -10 000 to 30 000 m | Default: 50 (-0.536 geoid) |
| ***Note**: You can define the initial height as relative to the WGS-84 ellipsoid, or to the local geoid. The relationship between local geoid and ellipsoid heights derives from reference* a) *and varies depending on latitude and / or longitude.* | | | |


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Clicking **Set…** opens this dialog in which you can enter the reference location in **ECEF coordinates**:




Notice **Latitude**, **Longitude** and **Height** update automatically as you move between the X, Y and Z positions.

| | | | |
|---|---|---|---|
| **X position (ECEF)**, **Y position (ECEF)**, **Z position (ECEF)** | Units: metres | Range: -1E10 to 1E10 m | |
| **Heading** | Units: degrees, minutes | | |
| **Speed** | Units: metres per second | Range: to 110 000 $m.s^{-1}$ | Default: 10 |
| **Heading Type** | Choose from **Constant Heading** (default) or **Great Circle**. | | |
| **Motion model version** | For backwards compatibility purposes, existing scenarios automatically select the appropriate motion model.<br><br>If you are creating a new scenario, you can choose the motion model you want to use from these SimGEN versions:<br>Pre v2.53<br>This model had very high accelerations and jerks (way beyond those specified in the personality limits) in an attempt at securing accuracy in achieving the specified motion.<br>v2.53 to v2.70<br>This model addressed the issue of very high accelerations and jerks; however, on occasions the motion was too subdued.<br>v2.71 onwards (default)<br>Where possible, this model ensures personality limits for accelerations are exercised at their limits. | | |

### 21.8.1.2 Accelerate

This command changes the speed of the ship. You specify it as a speed change, and a duration in which the speed change takes place. The chosen sea-state may modify the ship heading and height throughout the manoeuvre. Deceleration uses negative speed change.

| | | | |
|---|---|---|---|
| **Duration** | Units: seconds | Range: 0.0 to 32 400 s | Default: 100 |
| **Speed Change** | Units: metres per second | Range: ±110 000.000 $m.s^{-1}$ | Default: 10 |
| **Sea state type** | Glassy (0), Calm (1), Wavelets (2), Slight (3), Moderate (4)<br>Rough (5), Very Rough (6), High (7), Very High (8), or Phenomenal (9) | | |

### 21.8.1.3 Halt

This command stops (zero speed) the ship over a specified duration. If the **Halt** command is not the last command, a **Halt** command or an **Acceleration** command must follow the last command because all other commands assume non-zero initial speed.

After this manoeuvre, the ship maintains only the mean position; the chosen sea-state may cause the vehicle to move about this position.

| | | | |
|---|---|---|---|
| **Duration** | Units: seconds | Range: 0.0 to 32 400 s | Default: 100 |
| **Sea state type** | Glassy (0), Calm (1), Wavelets (2), Slight (3), Moderate (4)<br>Rough (5), Very Rough (6), High (7), Very High (8), or Phenomenal (9) | | |


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#### 21.8.1.4 Straight

Use this command for straight and level motion. Specify it using **duration** and/or a **distance**.

The ship will either continue at its current **height**, **heading** (**constant heading** or **great circle**) and **speed** for the **duration**, or **distance** you specify.

The **sea-state** you choose may modify the heading and height of the ship throughout the manoeuvre.

| | | | |
|---|---|---|---|
| **Duration** | Units: seconds | Range: 0 to 32 400 s | Default: 100 |
| **Distance** | Units: metres | Range: 0 to 10 000 000.0 m | Default: 50 |
| **Heading type** | Choose from:<br>Constant heading or Great circle see ***Reference*** (page 21-25) | | |
| **Sea state type** | Glassy (0), Calm (1), Wavelets (2), Slight (3), Moderate (4)<br>Rough (5), Very Rough (6), High (7), Very High (8), or Phenomenal (9) | | |

#### 21.8.1.5 Turn

Use this command to change the heading of the ship by a change in **heading**, the **duration** over which the turn is to take place and the maximum allowable **heel angle** (positive outwards) during the manoeuvre.

The **sea-state** you choose may modify the heading and height of the ship throughout the manoeuvre.

| | | | |
|---|---|---|---|
| **Heading change** | Units: degrees, minutes | Range: ± 9 999.0° | Default: 60 |
| **Duration** | Units: seconds | Range: 0.0 to 32 400 s | Default: 100 |
| **Heel angle** | Units: degrees, minutes | Range: -90.000° (in)<br>to +90.000° (out) | Default: 0 |
| **Sea state type** | Glassy (0), Calm (1), Wavelets (2), Slight (3), Moderate (4)<br>Rough (5), Very Rough (6), High (7), Very High (8), or Phenomenal (9) | | |

#### 21.8.1.6 Waypoint

***Note**: If you specify **Waypoints**, the motion is not re-locatable.*

Specify one or more Waypoints to define a trajectory passing through fixed points on the Earth's surface. Use this command to smooth the motion and prevent an abrupt change in the heading at the waypoint. The lateral dynamic limits and the yaw limits in the ship personality file define the turn radius of the ship.

| | | | |
|---|---|---|---|
| **Latitude** | Units: degrees, minutes | Range: N 90° 0' to S 90° 0´ | |
| **Longitude** | Units: degrees, minutes | Range: E 180° 0.0´ to W 180° 0.0´ | |
| **Heel angle** | Units: degrees, minutes | Range: -90.000° (in)<br>to +90.000° (out) | Default: 0 |
| **Sea state type** | Glassy (0), Calm (1), Wavelets (2), Slight (3), Moderate (4)<br>Rough (5), Very Rough (6), High (7), Very High (8), or Phenomenal (9) | | |

### 21.8.2 Personality file

***Note**: The **Ship** model does not use **Pitch** commands.*

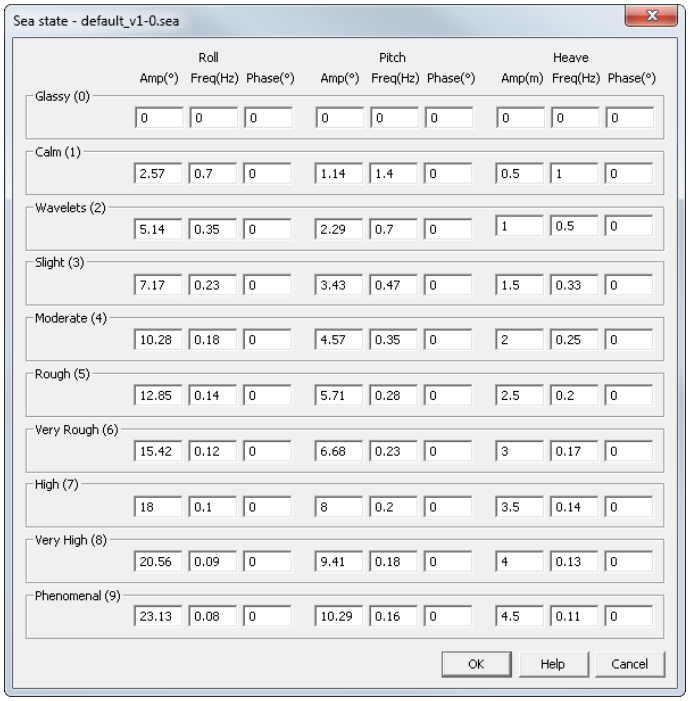
The ship model personality file, *default_vx-yy.tep,* described features and performance of the ship. By careful selection of dynamic limits, you can tailor the performance to that of individual vehicle types.

The Ship personality file is the same as **Aircraft-*Personality file*** (page 21-17)


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## 21.8.3 Sea-state file

This Sea state file, *default_vx-yy.sea*, describes a set of ten sea-state conditions. Spirent gives the ten sea-states the following names: Glassy (0), Calm (1), Wavelets (2), Slight (3), Moderate (4), Rough (5), Very Rough (6), High (7), Very High (8), and Phenomenal (9).




The above dialog shows the default values for each sea state. You can change the settings for each sea state fields, the following section gives the ranges of each parameter.

### 21.8.3.1 Sea state fields

***Note**: Resolution of stored data for all fields is four decimal places (in appropriate units).*

| | | | |
|---|---|---|---|
| **Roll amplitude** | Units: degrees | Range: 0.0 to 180° | |
| **Roll frequency** | Units: Hertz | Range: 0.0 to 5 Hz | |
| **Roll phase** | Roll phase specifies an offset allowing Roll to have the same frequency but a different “starting point”. This minimises cumulative effects.<br>Roll is sinusoidal. | | |
| | Units: degrees | Range: 0.0 to 360° | Default: 0 |
| **Pitch amplitude** | Units: degrees | Range: 0.0 to 90° | |
| **Pitch frequency** | Units: Hertz | Range: 0.0 to 5 Hz | |
| **Pitch phase** | Pitch phase specifies an offset allowing Pitch to have the same frequency but a different “starting point”. This minimises cumulative effects.<br>Pitch is sinusoidal. | | |
| | Units: degrees | Range: 0.0 to 360° | Default: 0 |
| **Heave amplitude**<br>**Vertical oscillation of ship** | Units: metres | Range: 0.0 to 50 m | |
| **Heave frequency** | Units: Hertz | Range: 0.0 to 5 Hz | |
| **Heave phase** | Heave phase specifies an offset allowing Heave to have the same frequency but a different “starting point”. This minimises cumulative effects.<br>Heave is sinusoidal. | | |
| | Units: degrees | Range: 0.0 to 360° | Default: 0 |

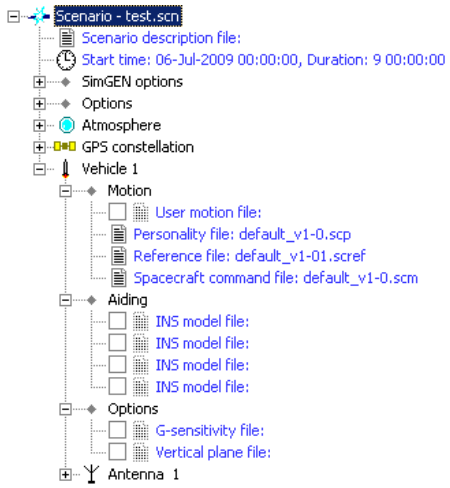

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# 21.9 Spacecraft

The spacecraft model lets you model a GNSS receiver in an Earth-orbiting spacecraft.

You define the initial position and velocity of the spacecraft in terms of the (Keplerian) orbital parameters, or ECEF / ECI position and velocity parameters. The motion of the spacecraft propagates from the initial condition as a function of perturbing accelerations (such as gravitational effects from the Earth, Sun and Moon, and atmospheric drag).

This figure and the following table detail the Spacecraft parameters

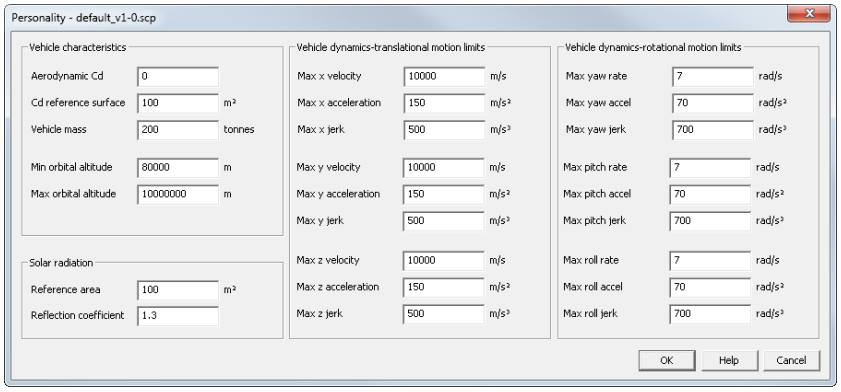



| Section | Description |
|---|---|
| **Motion-** | ***User motion files*** (page 21-38) |
| | ***Personality file*** |
| | ***Reference file*** (page 21-33) |
| | ***Command file*** (page 21-30) |
| **Aiding-** | ***INS error model*** (page 22-1) |
| **Options-** | ***G sensitivity file*** (page 21-41) |
| | ***Vertical plane file*** (page 21-41) |

The command file changes the orbit using thrusts or rotations.

## 21.9.1 Personality file

Edit the Spacecraft Personality file, *default_vx-yy.scp*, in the same way as the aircraft ***Personality file***.




The Dynamic Limits area is similar to the area with the same name in ***Aircraft*** (page 21-8)


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| | | | |
|---|---|---|---|
| **Aerodynamic Cd** | The spacecraft drag factor. SimGEN uses this value whatever the spacecraft orientation | | |
| | Units: none | Range: 0 to 100 | Default: 0 |
| **Cd reference surface** | A cross-sectional area SimGEN uses for drag calculations. SimGEN assumes a sphere and uses this value whatever the spacecraft orientation | | |
| | Units: $(metres)^2$ | Range: 0 to 10 000 $m^2$ | Default: 100 |
| **Vehicle mass** | Units: tonnes<br>(1 000 kg = 1 tonne) | Range: 0 to 1 000 | Default: 200 |
| **Min orbital altitude** | Units: metres | Range: 80 000<br>to 450 000 000 m | Default:<br>80 0000 |
| **Max orbital altitude** | Units: metres | Range: 80 000<br>to 450 000 000 m | Default:<br>10 000 000 |
| ***Note**: This orbital model is valid for altitudes between 80 000 m and 450 000 000 m.* | | | |
| **Reference area** ($A_R$) reflecting area of spacecraft | Units: $(metres)^2$ | Range: 0 to 10 000 $m^2$ | Default: 100 |
| ***Note**: **Reference area** will not change with vehicle attitude* | | | |
| **Reflection coefficient (CR)** | $C_R = 1 + \varepsilon$, where ε is the reflectivity of the vehicle. This is the fraction of the incident radiation that is reflected, with the remaining energy (1- ε) being absorbed. | | |
| | Units: none | Range: 0 to 2<br>normally > 1 | Default: 1.3 |
| **Max x velocity,**<br>**Max y velocity,**<br>**Max z velocity** | Units: metres per second | Range: 0 to 15 000 $m.s^{-1}$ | Default:<br>10 000 |
| **Max x acceleration,**<br>**Max y acceleration,**<br>**Max z acceleration** | Units: metres per $(second)^2$ | Range: 0.01 to 450.00 $m.s^{-2}$ | Default: 150 |
| **Max x jerk,**<br>**Max y jerk,**<br>**Max z jerk** | Units: metres per $(second)^3$ | Range: 0.01 to 550.00 $m.s^{-3}$ | Default: 500 |
| **Max yaw rate,**<br>**Max pitch rate,**<br>**Max roll rate** | Units: radians per second | Range: 0.001 to 7 $rad.s^{-1}$ | Default: 7 |
| **Max yaw accel,**<br>**Max pitch accel,**<br>**Max roll accel** | Units: radians per $(second)^2$ | Range: 0.001 to 70 $rad.s^{-2}$ | Default: 70 |
| **Max yaw jerk**<br>**Max pitch jerk**<br>**Max roll jerk** | Units: radians per $(second)^3$ | Range: 0.001 to 700 $rad.s^{-3}$ | Default: 700 |

### 21.9.2 Command file

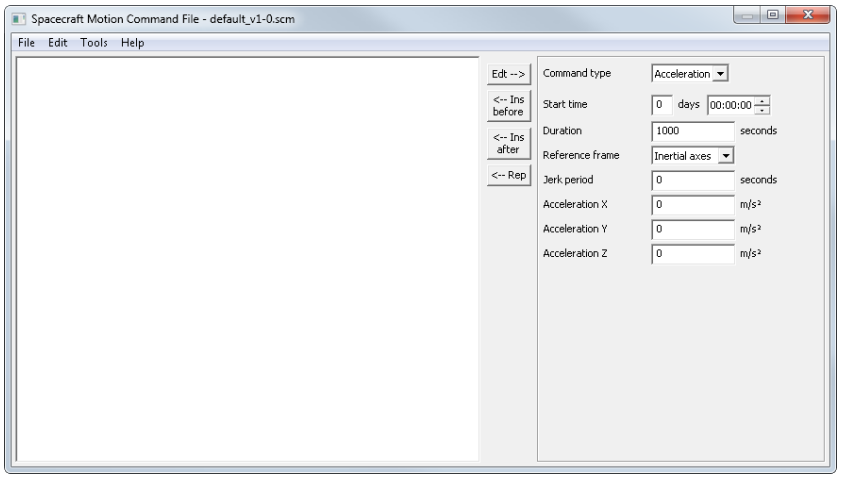
***Note**: You must manually build the Command file list in the order you want. SimGEN does not automatically order these actions.*

The Command file for this model contains a list of manoeuvres. Each manoeuvre has an associated set of parameters. These parameters define the duration and dynamics of the manoeuvre. The total duration of all commands may be longer or shorter than the scenario duration. If shorter, motion continues along the current trajectory after completion of the last command. If longer, the command list is truncated.



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This file, *default_vx-yy.scm*, allows a list of commands to modify the basic orbital motion in the ***Reference file*** (page 21-33) using the SimGEN ***List Editor*** (page 5-33):



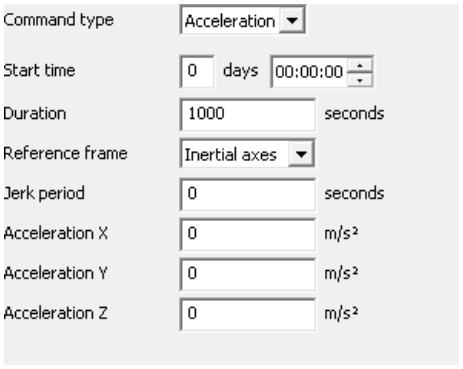

→ Select the **Command Type** you want to add to the Command file.

→ Enter the parameters for the **Command Type** you selected. This table shows the supported command types.

| Command Type |
|---|
| ***Acceleration command*** (page 21-31) |
| ***Orientation command*** (page 21-32) |
| ***Rotation command*** (page 21-32) |

### 21.9.2.1 Acceleration command

Use this command to set the acceleration of the Spacecraft.




| | | | |
|---|---|---|---|
| **Start time** | Enter the time (in days and hh:mm:ss) from the start of the scenario. | | |
| | Units: d hh:mm:ss | Range:<br>0 days 00:00:00<br>to 23 days 23:59:59 | Default:<br>0d 00:00:00 |
| **Duration** | Units: seconds | Range: 0.0 to 32 400 s | Default: 1 000 |
| **Reference frame** | Specify the spacecraft acceleration. Choose from: **Inertial axes** or **Body axes** | | |
| **Jerk period** | The rate of change from zero acceleration to the value of **Acceleration** and the rate of decrease to zero Acceleration at the end of the **Duration** | | |
| | Units: seconds | Range: 0 to 36 000 s | Default: 0 |

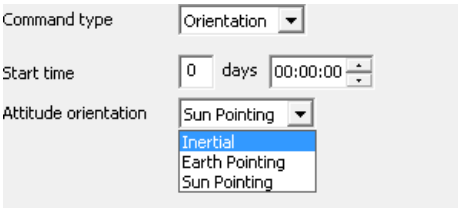

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| | | | |
|---|---|---|---|
| **Acceleration X, Y, Z** | The acceleration in each direction X, Y and Z.<br>Starting at **Start time** and lasting for **Duration**. | | |
| | Units: metres per (second)$^2$ | Range: ± 450 m.s$^{-2}$ | Default: 0 |

### 21.9.2.2 Orientation command

***Note**: Vehicle rotation does not take place at the start time you specify. SimGEN maintains the attitude at that time in the selected mode, unless changed by another command.*

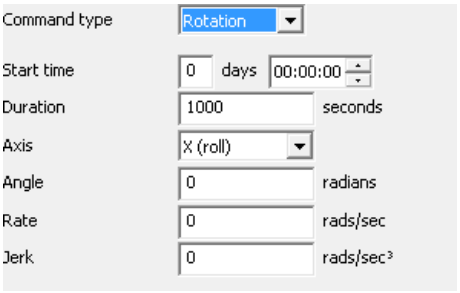
Use this command to set the orientation of the spacecraft.




| | | | |
|---|---|---|---|
| **Start time** | Enter the time (in days and hh:mm:ss) from the start of the scenario. | | |
| | Units: d hh:mm:ss | Range:<br>0 days 00:00:00<br>to 23 days 23:59:59 | Default:<br>0d 00:00:00 |
| **Attitude orientation** | Set the **Attitude orientation** of the spacecraft.<br>Choose from **Inertial**, **Earth pointing**, **Sun pointing** | | |

### 21.9.2.3 Rotation command

Use this command to set the rotation of the spacecraft.




| | | | |
|---|---|---|---|
| **Start time** | Enter the time (in days and hh:mm:ss) from the start of the scenario. | | |
| | Units: d hh:mm:ss | Range:<br>0 days 00:00:00<br>to 23 days 23:59:59 | Default: 0d 00:00:00 |
| **Duration** | Units: | Range: 0.0 to 32 400 s | Default: 1 000 |
| **Axis** | Choose from: **X (roll)**, **Y (pitch)**, **Z (yaw)** | | |
| **Angle** | Units: radians | Range: $10^5\pi$ rad | Default: 0 |
| **Rate** | Units: radians per second | Range: 0 to 7 rad.s$^{-1}$ | Default: 0 |
| **Jerk** | Units: radians per (second)$^3$ | Range: 0 to 700 rad.s$^{-3}$ | Default: 0 |

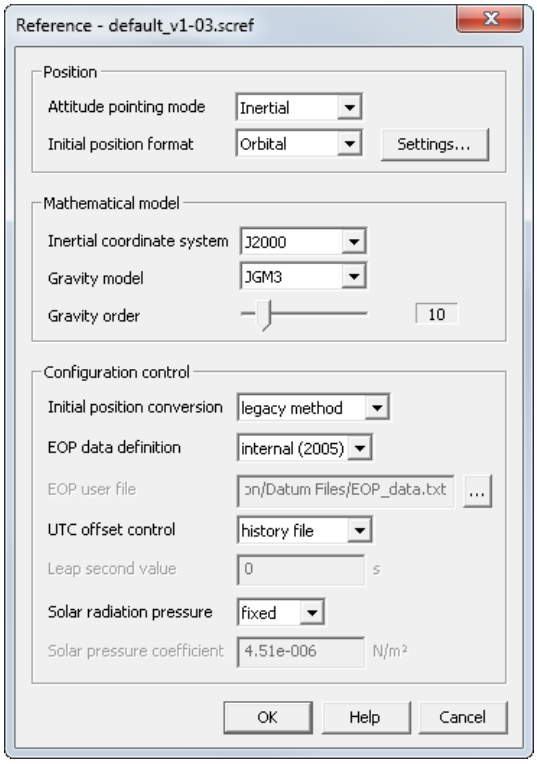


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### 21.9.3 Reference file

***Note**: From SimGEN v2-81 on the Spacecraft reference file extension has changed from *.scr to *.scref. You can specify Spacecraft reference files that use the old *.scr extension. When you save the scenario, SimGEN automatically saves the Spacecraft reference file with the new *.scref extension.*

The Spacecraft Reference file, *default_vx-yy.scref,* specifies the initial position and orbital plane of the spacecraft:




| | | | |
|---|---|---|---|
| **Position** | | | |
| **Attitude pointing mode** | Sets the spacecraft to maintain its initial attitude with respect to the Inertial reference frame, or an Earth Pointing or Sun Pointing attitude.<br>Choose from: **Inertial** (default), **Earth Pointing** or **Sun Pointing** | | |
| ***Note**: Rotational commands in the **Command file** (page 21-30) will modify the attitude.* | | | |
| **Initial position format** | Specify initial position and orbit using alternative forms. Choose from: Orbital (default), Vector or Terrestrial.<br>Set the terms for the **Initial position format**, by clicking on **Settings**, see the sections in ***Reference file*** (page 21-33) | | |
| ***Note**: Changing **Initial position format** does not convert the data. SimGEN independently retains both values.* | | | |
| **Mathematical Model** | Choose the **Inertial coordinate system** and **gravity** models. Spirent recommends you use the defaults. | | |
| **Inertial co-ordinate system** | Choose from the B1950 or the later J2000<br>Default: **J2000** | | |
| | Units: none | Range: 0 to 100 | Default: 0 |
| ***Note**: Spirent used the **B1950 model** in SimGEN for VMS. Choose the **B1950 model** only if you need backward compatibility.* | | | |
| **Gravity model** | Choose from **GEM10** or the later **JGM3**.<br>Default: **JGM3** | | |
| ***Note**: Spirent used the **GEM10** model in SimGEN for VMS. Choose the **GEM10** model only if you need backward compatibility.* | | | |


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| | |
|---|---|
| **Gravity order** | Slide to set the number of terms the gravity model uses. More terms make the gravity model more precise, but require more time to compute.<br>Default: 10<br>The box to the right of the slider shows the **Gravity order**. |
| ***Note**: The spacecraft model updates at the rate you select in the menu item **General Options** **-Simulation Iteration Rate** (page 5-15). When using the spacecraft model, Spirent recommends you use 100 milliseconds iteration rate. SimGEN will meet the demands of propagating the orbit for gravity models using the maximum value of **Gravity order** at all iteration rates. However, there is no benefit in using rates higher than 100 milliseconds for modelled data.* | |
| **Configuration control** | Select alternatives to SimGEN's terrestrial modelling coefficients |
| ***Notes**:*<br>***1)** SimGEN applies the selected coefficients in converting the initial ECI referenced position, or orbital definition, into the ECEF frame.*<br>***2)** SimGEN applies precession, nutation, polar motion, leap seconds and delta UT1 in determining the initial position of the spacecraft in the ECEF frame. During the simulation, SimGEN propagates the ECI to ECEF transformation from the initial state purely as a function of linear Earth rotation using the rotation-rate you specify.*<br>***3)** If you select **Gravity model-GEM-10** SimGEN always applies legacy data.*<br>***4)** The default terrestrial modelling coefficients are the models used by SimGEN up to version v2.71.* | |
| **Initial position conversion** | |
| **legacy method** | The default method, uses these fixed values: |
| **Earth rotation-rate** | 7.292 115 146 7 E-5 rad.s$^{-1}$ |
| **Earth gravitational constant** | 398 600.47 E+9 km$^3$.s$^{-2}$ |
| **improved method** | Uses these fixed values: |
| **Earth rotation-rate** | (WGS-84, NIMA 1997) 7.292 115 855 30 E-5 rad.s$^{-1}$ |
| **Earth gravitational constant** | (JGM-3) 398 600.4415 E+9 km$^3$.s$^{-2}$ |
| **EOP data definition** | Earth Orientation Parameters (polar motion and delta UT1) are from internal tables or from a user-defined file.<br>Choose from: |
| **internal (2001)** | Uses SimGEN's original method, which:<br>i) Interpolates polar motion offsets from a table with data at a 3-monthly interval, valid up to October 2001.<br>After this time, the polar offsets are set to zero.<br>ii) Up to 1996, applies approximate values for delta UT1.<br>iii) After 1996, sets delta UT1 to zero. |
| ***Note**: SimGEN V2-52 replaced **internal (2001)** with the **internal (2005)** method.* | |
| **internal(2005)** | (default) Up to October 2005 - Reads polar motion data from an internal table containing offset values at a daily interval.<br>After October 2005 - The offsets are set to zero.<br>Handles Delta UT1 as for **internal (2001)**. |
| ***Note**: Spirent retains methods using internally tabulated EOP data for backward compatibility only. Spirent recommends you do not use these methods for newly defined scenarios.* | |
| **disabled** | Sets Earth Orientation Parameters (Polar motion and delta UT1) to zero.<br>Use to select a scenario start time that is in the future |


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| | |
|---|---|
| **user file** | Use Earth Orientation Parameters (polar motion and delta UT1) from a user-defined file.<br>Click on the **...** button to navigate to the file (**.txt* format) you want to use.<br>The default file, *EOP_data.txt*, is located in the folder: *D:\posapp\software\<version>\gui \Datum Files* (for GSS8000-series and earlier signal generators the default folder is *C:\Program Files\Spirent Communications\Positioning Application\Datum Files).*<br><br>You will see a warning in the **System Messages** window if the last data line in your *EOP_data.txt* , file is more than 100 days older than the start date of your scenario.<br>The content and format of this file is from the data files available from the IERS (International Earth Rotation Service) web site, see this page:<br>http://datacenter.iers.org/eop/-/somos/5Rgv/latest/213<br><br>Before updating the file *EOP_data.txt*, Spirent recommends you first make a copy of the existing file.<br>You must remove the initial heading text and records prior to the earliest available scenario date of 1st January 1980.<br><br>As changes in polar motion are not very predictable, these files are generally only valid for scenario start times up to the date you downloaded the file. For scenarios starting after the final entry in this file, the EOP parameters are set to the values in this last data-set and do not change throughout the run.<br>There may be a small difference in the initial ECEF position for scenarios with a start time that were previously in the future and are now within the range of the available EOP data. To prevent this, copy and rename the EOP data file and use this as the reference for scenarios starting at some time in the future, or introduce your own update at regular intervals using the link above. |

***Notes**:*

***1)** Typically Spirent supplies the default file EOP_data.txt as part of major PosApp releases.*
*Spirent may update this file to include the latest available information. Some navigation data messages (such as GPS L2-CNAV message type 32 and IRNSS message type 11) also use data in this file, and if the file updates the navigation data message may change.*
*Spirent recommends you always use the latest, default, file when using the spacecraft model.*

***2)** The installer will overwrite any existing file with the name EOP_data.txt in the default folder location.*

| | |
|---|---|
| **UTC offset control** | ***Note**: You must set **UTC offset control** to the same setting as you use in **Start time-UTC offset control** (page 4-15). Typically, this will be **UTC offset control-automatic**, which uses the history.txt file, so you must use **UTC offset control-history file** (the default setting). Do not use **internal (2001)***<br><br>Define the number of leap seconds current at the start of the scenario. Choose from: |
| **internal (2001)** | Determines the leap second using the legacy method (an internal table of leap second values) |

***Note**: This method is only valid up to 2001.*
*Later start times use a projection of future leap second events, which is not representative of the actual leap second history since this time.*
*Only use this option for backward compatibility.*

| | | | |
|---|---|---|---|
| **fixed** | Define the number of leap seconds to apply<br>This value is the difference between the current UTC time and TAI.<br>Use this option when, at the time of scenario creation, the start time is in the future. It ensures the initial vehicle position will not change if you update the leap second history. | | |
| | Units: seconds | Range: 0 to 100 s | Default: 0 |
| **history file** | (default) Uses the file *…\Positioning Application\Datum files\leap seconds history.txt,* which contains the leap second history since GPS started.<br>If you update this file with further leap second events as they become applicable, you must maintain the original Spirent file format. | | |


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| | | | |
|---|---|---|---|
| ***Note**: Spirent may update the history.txt file in future SimGEN releases.* | | | |
| **Solar radiation pressure** | ($P_{SR}$) | | |
| **fixed** | (default) Applies a constant acceleration of 1.47 E-07 $m.s^{-2}$ to the spacecraft, in the opposite direction to the Sun (This is the legacy condition) | | |
| **variable** | Type the solar radiation pressure ($P_{SR}$) you want to use in the **Solar pressure coefficient** text box. SimGEN calculates the solar radiation acceleration, in $m.s^{-2}$, using $P_{SR}.C_R.A_R$ / M<br><br>Where:<br>the ***Personality file*** (page 21-29) defines $C_R$, $A_R$ and M (vehicle mass, kg) | | |
| **Solar pressure coefficient** | Units: Newtons per $(metre)^2$ | Range: 0 to 1.0 E-05 $N.m^{-2}$ | Default: 4.51 E-06 $N.m^{-2}$ See Note 1) below |

***Notes:***

***1)*** *The default value for **Solar radiation pressure-variable** (PSR = 4.51E-06 $Nm^{-2}$) and the default values for Personality file parameters vehicle mass (M = 200 tonnes) Reflection coefficient (CR = 1.3) and Reference area (AR = 100 $m^2$) result in a lower value of solar radiation acceleration than if you use **Solar radiation pressure-fixed**.*
*You can get an equivalent to **Solar radiation pressure-fixed** by, for example, using Reference area (AR) = 250 $m^2$ and vehicle mass (M) = 10 tonnes.*

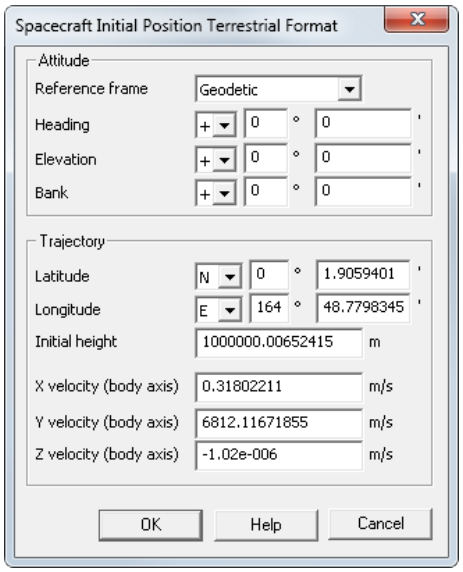
***2)*** *Currently, solar radiation pressure (PSR) does not vary with distance from the Sun.*

***3)*** *When the spacecraft is in the Earth's shadow, solar radiation pressure (PSR) is set to zero.*

***4)*** *SimGEN will apply zero solar radiation acceleration if you set PSR, CR or AR to zero.*

### 21.9.3.1 Initial position format - Terrestrial

This dialog defines the initial position using terrestrial co-ordinates.



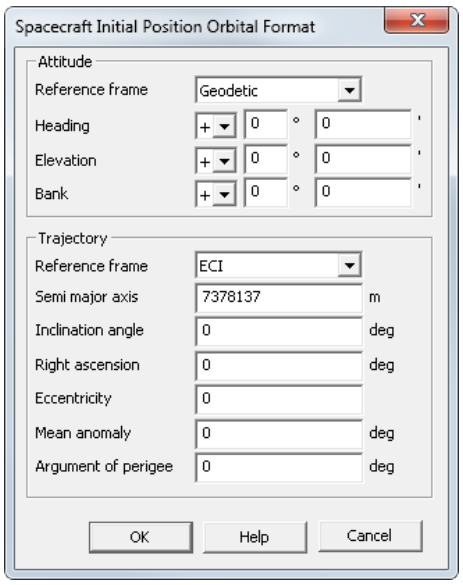

| | |
|---|---|
| **Attitude** | Specify the attitude parameters in either Geodetic or Orbital reference frames. Changing the reference frame re-calculates the attitude values. |
| **Trajectory** | Specify the trajectory with respect to the **Latitude**, **Longitude** and **Initial height** using X, Y, Z (body axis) velocities. |

### 21.9.3.2 Initial position format - Orbital

This dialog defines the initial position using orbital co-ordinates.



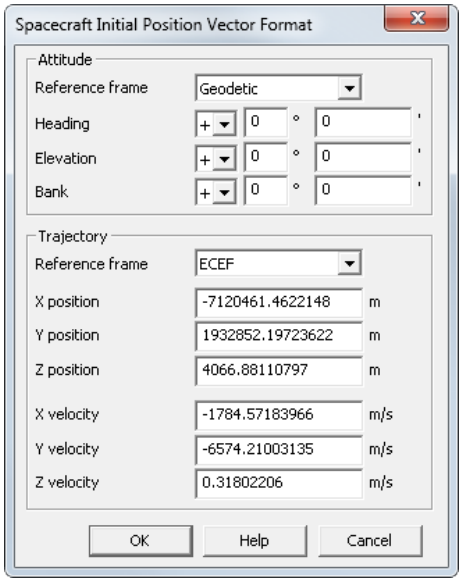
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| | |
|---|---|
| **Attitude** | Specify the attitude parameters in either Geodetic or Orbital reference frames. Changing the reference frame re-calculates the attitude values. |
| **Trajectory** | Specify the trajectory with respect to either an ECI or ECEF reference frame using **Semi major axis**, **Inclination angle**, **Right ascension**, **Eccentricity Mean anomaly** and **Argument of perigee**. |

#### 21.9.3.3 Initial position format - Vector

This dialog defines the initial position using vector co-ordinates.



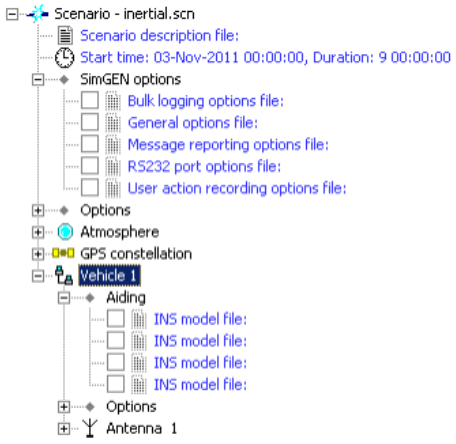

| | |
|---|---|
| **Attitude** | Specify the attitude parameters in either Geodetic or Orbital reference frames. Changing the reference frame re-calculates the attitude values. |
| **Trajectory** | Specify the trajectory with respect to either an ECI or ECEF reference frame using **X**, **Y**, **Z position** and **X**, **Y**, **Z velocity**. |

## 21.10 Remote motion

Use Remote motion to send motion commands from an external source, such as test equipment, to SimGEN.

Remote motion commands in SimGEN always refer to the Centre of Gravity (CofG) of the vehicle. Use ***Offsets file*** (page 23-6) to offset the antenna from the vehicle CofG. This figure and the following table detail the Remote motion parameters:


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| Section | Description |
|---|---|
| **Vehicle1-Aiding-** | ***INS error model*** (page 22-1) |
| **Vehicle1-Options-** | ***G sensitivity file*** (page 21-41) |
| | ***Vertical plane file*** (page 21-41) |
| | ***Motion sensors file (SimAUTO)*** (page 21-41) |

## 21.11 User motion files

***Notes***:

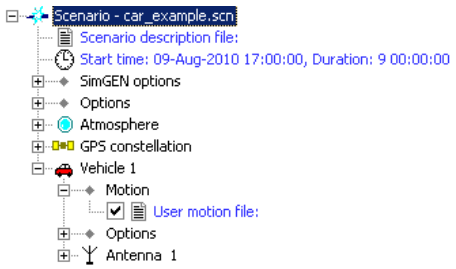
***1)*** *The User Motion file defaults to the SimREMOTE MOT command if no keyword is present. You must include the keyword MOTB in the User Motion file if you are using the SimREMOTE MOTB command.*

***2)*** *The User Motion file does not require the vehicle type as the vehicle type is implied.*

***3)*** *The first MOT or MOTB position message determines the motion of the vehicle at the start of the scenario, even if the time-stamp of the message does not match the scenario start time. SimGEN will use subsequent messages correspondingly.*

You can use User Motion files with the **Land Vehicle**, **Ship**, **Aircraft** and **Spacecraft** models. User motion files have the extension **.umt*.

To select a User Motion file, first expand **Scenario-Vehicle-Motion**. Select **User motion file** (ensure there is a tick in the box, as shown in the figure below) and right-click **User motion file**. Click on **Select** and choose the User Motion file you want to use in your scenario.




You can generate User Motion files using the MOT (ECEF axes) command, or the MOTB (latitude / longitude / height axes) command - see reference qq); or from NMEA files, see the following section.

The key difference between using a User Motion file and using the remote vehicle type, is that the User Motion file is directly associated with the scenario.

Examples:

User Motion file without MOTB keyword, so default is MOT:

```
0 00:00:01,4058735.385,-251461.3003,4897339.144,1.363,2.819,-0.035,
0.512,-0.467,-0.624,0,0,0
```


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User Motion file with MOTB keyword:

```
00:00:01,MOTB,1.456154,-2.671657,100,1.591,3.529,0.176,1.079,
2.316,0.027,0,0,0
```

Reference qq) gives a full description of the syntax of the MOT and MOTB keywords.

### 21.11.1 NMEA motion file

***Notes**:*

***1)** If the time-stamp of the first NMEA position message does not correspond to the scenario start time, then Spirent assumes it does apply at the scenario start time and offsets subsequent message timestamps accordingly. For example: if the Scenario start time is 2nd Jan 2008 12:00,and the first NMEA message time-stamp is 1st Jan 2007 00:00 the position in the first NMEA massage is taken to be at scenario start time and subsequent message timestamps will have 1 year, 1 day 12 hours added to them to determine their time of validity.*

***2)** If you use the GPS satellite almanac relating to the recorded NMEA motion, you must set the scenario start time to correspond to the NMEA data time. This ensures the simulated satellite positions will correspond to the positions of the satellite at the time of recording the NMEA data.*

***3)** The NMEA file must contain position messages. Generally, the more frequently the transmission of position messages, the better the resulting motion.*

***4)** There may be some trade-offs depending upon the level of noise and bias on the positions. To follow large, frequently changing errors in NMEA data, SimGEN will simulate unexpectedly high dynamics.*

***5)** SimGEN generates motion that is consistent with position changes corresponding to preceding derivative data.*

***6)** NMEA motion files must have the extension *.umt.*

***7)** Spirent recommends you use an NMEA motion file instead of the utility **NMEA to User Motion** (page 26-49), which Spirent no longer supports.*

You can also use a User Motion file containing NMEA messages to specify vehicle motion.

***Remote motion*** (page 21-37) details selecting a **.umt* motion file. NMEA messages that contain high-quality motion data let SimGEN simulate good approximations to vehicle motion. SimGEN supports these NMEA message types: GGA, GNS, GLL and RMC.

SimGEN uses a cubic-spline to interpolate motion between NMEA messages. The rate of NMEA messages does not have to be high or at regular intervals, however, noise on the NMEA message data will influence the dynamics of the simulated motion. Spirent recommends using the menu item **Options-*Bulk logging options*** (page 5-1) to appreciate the dynamics of the simulated motion.

### 21.11.2 Interpolated motion commands

***Notes**:*

***1)** The choice of each command depends on whether you are interpolating data from NMEA files or MOT / MOTB keywords.*

***2)** Parameter values that are missing during the decoding process, such as geoidal separation, will default to 0.0*

***3)** If you do not define altitude data, or it is missing, the altitude data will take the value of its adjacent data set, otherwise it will default to 0.0.*

You can select one or more interpolated motion commands to give interpolated motion data for all data in a User Motion file. Interpolated data may be more accurate than data in the original User Motion file.

Each interpolated motion command applies a cubic-spline fit to your selected User Motion file (based on NMEA files), MOT or MOTB keywords. Spirent implements interpolation by fitting a cubic-spline to four positional points and obtaining motion from the derivative of this curve. Ideally, motion files using interpolate commands should be 'complete' with no missing time-stamped data. However, if your scenario uses a long static period at the start (and you want to avoid duplicating the t=0 seconds motion message) you can insert a minimum of three motion records, which are duplicates of the t=0 seconds motion command, with their timestamps changed to just before the time you want the motion to begin.

For example, if your scenario needs motion ten minutes after the scenario start:

- → Create a motion message for time 00:00:00.0 - this gives the initial position
- → Copy this command
- → Paste this command three times after the motion message for time 00:00:00.0


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→ Change the timestamps on the three pasted commands to:
00:09:57.0
00:09:58.0
00:09:59.0

→ The vehicle will remain static for the first 10 minutes of the scenario

This table details the interpolated motion commands:

| Command | Description | NMEA | MOT / MOTB |
|---|---|---|---|
| INTERP_VEL | Interpolate for linear velocity (and acceleration and jerk terms) from position data | Not required | Valid |
| INTERP_ACC | Interpolate for linear acceleration (and jerk term) | Not required | Valid |
| INTERP_JERK | Interpolate for linear jerk | Not required | Valid |
| INTERP_HEAD | Interpolate for heading (and angular rate and acceleration terms) from trajectory path. Bank is assumed to be zero | Not required | Valid |
| INTERP_ELEV | Interpolate for elevation (and angular rate and acceleration terms) | Not required | Valid |
| INTERP_ANG_RATE | Interpolate for angular rate (and angular acceleration term) | Not required | Valid |
| INTERP_ANG_ACC | Interpolate for angular acceleration | Not required | Valid |

Use a text editor such as *Notepad* to add a new first line to the original User Motion file where you specify the interpolation command(s) you want to use. Add these commands as the first line of the modified file. Their order is not important.

You must save the modified file with the extension **.umt*. ***Remote motion*** (page 21-37) details using the **.umt* file.

This example code listing shows the first few lines of an MOTB file, modified to use all the interpolation commands.

```
INTERP_VEL, INTERP_ACC, INTERP_JERK, INTERP_HEAD, INTERP_ANG_RATE,
INTERP_ANG_ACC
0,motb,v1_m1,0.8804458274013311,-0.0625714499473983 1,0,0,0,0,0,0,0,0,0,-
1.367035543871698,0,0
9.939,motb,v1_m1,0.8804475727305832,-0.0625847144497134 7,0,0,0,0,0,0,0,0,0,-
1.5221247446520911,0,0
21.585,motb,v1_m1,0.8804390206172484,-0.0626325364712181 2,0,0,0,0,0,0,0,0,0,-
2.818193600912254,0,0
40.013,motb,v1_m1,0.8804405914135752,-0.0626581928112224 4,0,0,0,0,0,0,0,0,0,-
1.5978603502201334,0,0
56.122,motb,v1_m1,0.880426454246634,-0.0626672685233328,0,0,0,0,0,0,0,0,0,-
2.962535796658696,0,0
75.539,motb,v1_m1,0.88040987361874,-
0.0626719809123131 9,0,0,0,0,0,0,0,0,0,3.1097609767381047,0,0
```

Currently, SimGEN supports NMEA message types GGA, GNS, GLL and RMC. The **System Messages** window warns you if the **.umt* file contains an unsupported message. The text of typical messages is:

00:00:02 Warning: Invalid message ID 'RMB' in user motion file line #104

00:00:02 Warning: Invalid message ID 'GSA' in user motion file line #106

For all files, SimGEN applies the first motion message at the start time of the scenario and offsets subsequent message times accordingly. You can also use the message types VTG (speed) and HDT (heading). VTG and HDT are not associated with a specific time; the default association is with the time-stamp **preceding** the keyword.

Use the keywords VTG_TO_NEXT_MOT and HDT_TO_NEXT_MOT to associate VTG (or HDT) with the time-stamp **following** the keyword if required (this is receiver dependant). You must add these keywords to the first line of the modified User Motion file.


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As the data file does not necessarily contain NMEA data, SimGEN is unable to discern invalid data from valid data. Before using the modified **.umt* file you must delete all invalid records from the start of the modified file.

### 21.11.3 Navigation from the Moon

***Note**: To use navigation from the Moon, you must use a GSS8000-series signal generator running firmware version 2-27 or later, or a GSS9000-series signal generator*

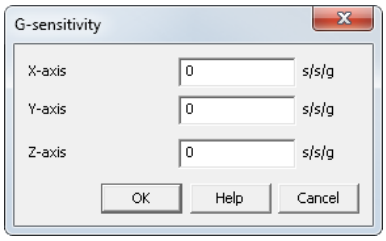
You must use user motion files when working with navigation from the Moon. Using user motion files allows SimGEN to support pseudoranges up to 450 000 000 metres, (pseudorange delays up to 1.5 seconds). Currently SimGEN supports this extended pseudorange only for Galileo and GPS constellations.

When working with navigation from the Moon, you must define vehicle position in ECEF XYZ co-ordinates.

Also, see ***Earth obscuration*** (page 10-11) to ensure you set up SimGEN to simulate satellites directly below the Moon.

## 21.12 G sensitivity file

This model simulates the change in a receiver's crystal oscillator when it is subject to a force (G-sensitivity). It models the receiver as though it were at the centre of gravity for the motion. The G-sensitivity filename is *default_vx-yy.g_sense*.




SimGEN models an equivalent to the receiver's crystal oscillator, using the equation below, to obtain the frequency shift, Δf, of each satellite signal. The frequency shift is the product of the sensitivity vector, $\gamma$, and the component of vehicle acceleration, a, that aligns with the sensitivity vector.

$$\Delta f = S_i . a_i + S_j . a_j + S_k . a_k$$

Where:

$\gamma = S_i \underline{i} + S_j \underline{j} + S_k \underline{k}$

$a = a_i \underline{i} + a_j \underline{j} + a_k \underline{k}$

$S_i$, $S_j$, $S_k$ are the **X-axis**, **Y-axis** and **Z-axis** parameters you enter in the dialog.

| | | | |
|---|---|---|---|
| **X-axis, Y-axis, Z-axis** | Units: seconds per second per g | Range: $\pm$2.0 E-8 $s^{-2}.g^{-1}$ | Default: 0 |

## 21.13 Vertical plane file

**Channel assignment and multipath types-*Vertical plane*** (page 24-12) simulates an urban environment with satellite signal reflection from building surfaces.

## 21.14 Motion sensors file (SimAUTO)

***Notes**:*

***1)** For GSS9000-series and GSS7000 signal generators, SimAUTO uses PCIexpress I/O cards.*

***2)** For GSS8000-series and earlier signal generators, Spirent uses drivers for the third-party PCI I/O cards that only support 32-bit Windows. This means you must install the executable SimAUTO.exe on a 32-bit machine. If you want to run SimAUTO on the same machine as SimGEN, this means you must install SimGEN on a 32-bit machine.*

SimGEN can simulate automotive motion sensors using the Motion sensors file and two, optional, I/O cards in the C50r SimGEN Host for GSS9000-series signal generators, the Embedded Host for GSS7000 signal generators (or the SimGEN Controller for GSS8000-series, or earlier, signal generators). One I/O card provides the analogue outputs for a heading rate table, the other I/O card provides digital outputs including individual wheel motion or "wheel ticks". SimGEN currently supports outputs including odometer, heading rate gyro and the capability to control an external rate table.


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Alternatively, SimGEN version 2-91 onwards can provide these outputs by using motion data from a file, rather than its motion models.

SimGEN version 2-61 onwards creates default files, with a filename format *default_vx-yy.<extension>*.

SimGEN version 4-02 SR01 onwards uses the separate application SimAUTO (*SimAUTO.exe*) in conjunction with the motion sensors file to calibrate the **Rotation rate sensitivity** and **Zero rotation rate offset** of the rate table, see ***SimAUTO application*** (page 21-53).

SimGEN version 5-02 onwards supports SimAUTO running on the C50r SimGEN Host.

PosApp version 6-00 onwards supports SimAUTO running on the GSS7000 Embedded Host.

## 21.14.1 Enabling motion sensors

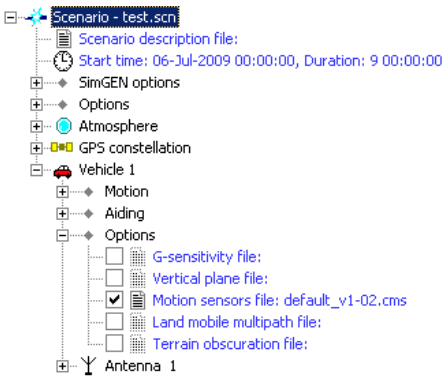
***Notes:***

***1)*** *The **Motion Sensors** option only displays when one of the two peripheral I/O cards is present in the C50r SimGEN Host (GSS9000-series signal generator) or the SimGEN Controller (GSS8000-series or earlier signal generators), or when SimGEN operates in **No Hardware** mode. In this mode, the optional settings display, but sensor outputs are not present.*

***2)*** *To install the I/O cards see the SimAUTO Release Notes supplied with the Upgrade Package.*

***3)*** *You can select Motion Sensors for either a Land vehicle or the Remote controlled vehicle. Only one vehicle can be set to generate the sensor data at a time.*

Allocate the ***Land vehicle*** (page 21-19) to your scenario and then highlight **Options-Motion sensors file**. Selecting a vehicle enables sensor outputs for that vehicle only when a tick is present in the check box.




Double-click **Motion sensors file** to edit the file.

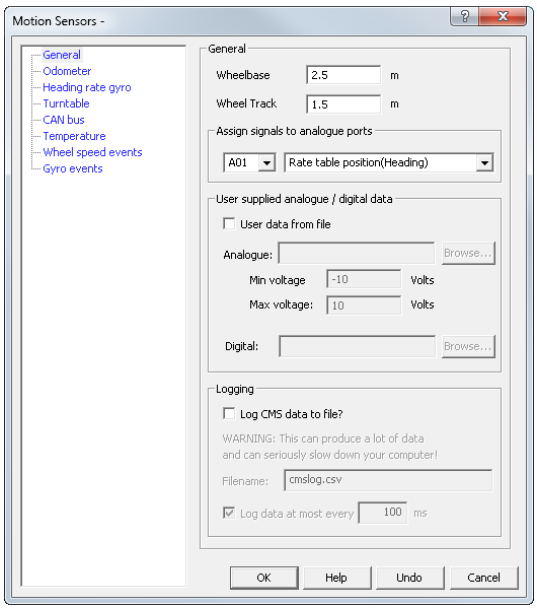
## 21.14.2 General

The SimGEN **Land vehicle** model calculates motion for the nominal vehicle centre of gravity (CofG). SimGEN assumes the vehicle CofG is at ground level, at a point beneath the centre of the rear axle. Use **Receive and transmit antennas-Options-*Offsets file*** (page 23-6) to specify the position of the GNSS antenna relative to the vehicle CofG.

SimGEN calculates rotational motion as rotation about the CofG and derives wheel speeds by considering the relative positions of the contact patches of the wheels in relation to the centre of radius of the turn.

Use the **General** dialog to set basic dimensions:


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| | | | |
|---|---|---|---|
| **Wheelbase** | The distance between the centres of the front and rear wheel contact patches. | | |
| | Units: metres | Range: 0 to 25 m | Default: 2.5 |
| **Wheel Track** | The distance between the centre of the contact patches of the left and right wheels. SimGEN assumes the front and rear pairs of wheels have the same **Wheel track**. | | |
| | Units: metres | Range: 0 to 5 m | Default: 1.5 |
| **Assign signals to analogue ports** | For each of ports **A01** to **A04** select the signal from the drop-down list, see ***Default analogue ports*** (page 21-44) | | |
| **User supplied analogue / digital data** | Specify the files providing the analogue and digital data that will generate the I/O card outputs, rather than generating the I/O card outputs using SimGEN's motion models. You must also provide a user motion file that describes the vehicle trajectory with respect to time.<br>***Data from file*** (page 21-44) describes these three files. | | |
| **User data from file** | Deselect (default): uses SimGEN's motion models to generate I/O card outputs<br>Select: use data files to generate I/O card outputs | | |
| **Analogue:, Digital:** | ***Note****: You must use an analogue AND a digital data file*<br>Click **Browse** and navigate to the location of your analogue and digital data files. | | |
| **Min voltage, Max voltage** | Set the voltages corresponding to the minimum and maximum values for your analogue heading rate gyro | | |
| | Units: Volts | Range: -10 to +10 V | Default: -10 V (Min)<br>+10 V (Max) |
| **Logging** | The log file is a comprehensive record of the sensor and error data. This data is useful when setting tests that apply error events, so you can examine and adjust the magnitude of the event you apply. However, if you run at the high-rate, logging the CMS data may affect the timing of the simulation. In this case, you can record the log data as a pre-simulation exercise and then, for your test run, deselect Log CMS data to file? | | |
| **Log CMS data to file?** | Deselect (default): does not save sensor data, wheel speeds, gyro rates and the error values SimGEN applies to these sensor values<br>Select: saves sensor data, wheel speeds, gyro rates and the error values SimGEN applies to these sensor values.<br>Enables Log CMS data at most every text box. Type the rate at which you want to collect data.<br>Choose the CMS filename, which SimGEN saves to the current scenario folder. | | |


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#### 21.14.2.1 Default analogue ports

Spirent provides a cable assembly that gives access to the analogue outputs provided by the analogue I/O card. This table shows the default settings for the cable outputs.

| Cable output | Data | Parameter description | Calculations |
|---|---|---|---|
| A1 | Rate table position | ***Turntable*** (page 21-49) | ***Rate table position as an analogue voltage*** (page 21-57) |
| A2 | Heading rate gyro | ***Heading rate gyro*** (page 21-48) | ***Heading rate as an analogue voltage*** (page 21-48) |
| A3 | Rate table speed | ***Turntable*** (page 21-49) | ***Rate table speed as an analogue voltage*** (page 21-58) |
| A4 | Gyroscope temperature | ***Temperature*** (page 21-50) | ***Gyroscope temperature as an analogue voltage*** (page 21-51) |

### 21.14.3 Data from file

Data from file uses a user motion (**.umt*) file in conjunction with two data files (providing analogue and digital data) to generate the I/O card outputs.

The following sections describe these three files.

#### 21.14.3.1 User motion file

***Note**: You must ensure the analogue and digital data files are time correlated with the user motion file. SimGEN does not check for correctly correlated data, incorrectly correlated data will result in a lack of fidelity at the I/O card outputs.*

The user motion file is a time-ordered list of Spirent's remote MOT/MOTB commands at a rate of at least 1 Hz. You can generate this file from raw NMEA data using Spirent's Check Motion utility. Reference hhh) describes using this utility.

The maximum rate SimGEN reads data from the user motion file is 100 Hz. To achieve the maximum rate you must supply timestamps at 10 millisecond intervals.

#### 21.14.3.2 Analogue data file

***Note**: You must ensure the analogue data file is time correlated with **Data from file-User motion file** (page 21-44). SimGEN does not check for correctly correlated data, incorrectly correlated data will result in a lack of fidelity at the analogue I/O card output.*

This is a plain ASCII text file, using the extension **.txt*, containing heading rate gyro data for the scenario.

The analogue data file can contain optional comments on lines beginning with '!'. The analogue data file uses a header line to define the optional voltage-scaling factor SimGEN uses to convert the data in the analogue file to match the range it needs. If you do not provide a voltage-scaling factor, SimGEN uses a default of 1.0. The file uses a separate header line to define the scenario start time, which allows you to use a new start time without modifying each time-stamp.

The rest of the file consists of lines containing a time-stamp and heading rate gyro data for the duration of the scenario. You must use the time of applicability for the time-stamp, which is referenced to the scenario start time. The heading rate gyro data is an integer number, range 0 to 65 536. The voltage output from the analogue I/O card uses 16-bit resolution, giving a range of ±32 768, to represent heading rate gyro values. This means the default voltage range (±10 V) of the I/O card gives a resolution of around 0.305 1 mV. You can offset this value from the zero voltage by typing a value for **Zero rate offset** in ***Heading rate gyro*** (page 21-48).

You must set the limits of the output voltage range using **Motion sensors file-General-Min voltage** and **-Max voltage**.

The analogue data file format is:

```
!Optional comment
Voltage scalar: {nnn.n}
!Optional comment
Scenario start time: {dd-mmm-yyyy hh:mm:ss}
Timestamp (sss.sss), Voltage
```


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```
Timestamp (sss.sss), Voltage
Timestamp (sss.sss), Voltage
.
.
```

Example analogue data file:

```
! Definition of rate gyro output voltage scaling factor
Voltage scalar:{20000.0}
! Definition of scenario start time
Scenario start time: {08-FEB-2003 12:59:59}
0.000, 32710
0.200, 32716
0.400, 32707
.
.
```

### 21.14.3.3 Digital data file

***Note**: You must ensure the digital data file is time correlated with **Data from file-**User motion file (page 21-44) SimGEN does not check for correctly correlated data and incorrectly correlated data will result in a lack of fidelity at the digital I/O card output.*

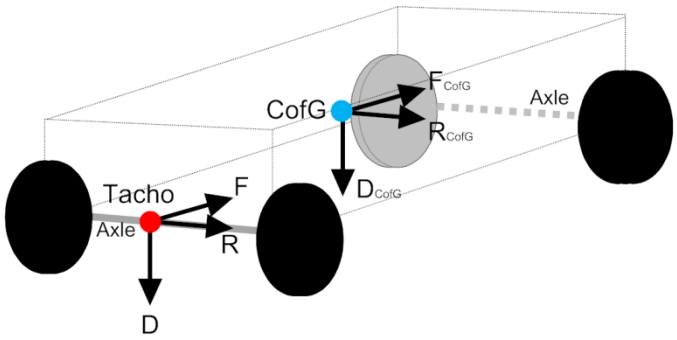
This is a plain ASCII text file, using the extension **.txt*, containing tachometer and drive direction data for the scenario.

The digital I/O card provides the digital pulses (or “wheel ticks”) shown in this table, together with drive direction indication.

| Card output | Parameter |
|---|---|
| 1 | Vehicle speed |
| 2 | Vehicle front axle speed |
| 3 | Vehicle rear axle speed |
| 4 | Vehicle front left wheel speed |
| 5 | Vehicle front right wheel speed |
| 6 | Vehicle rear left wheel speed |
| 7 | Vehicle rear right wheel speed |
| 8 | Drive direction indicator<br>reverse = 0<br>forward = 1 |

SimGEN uses the geometry of the vehicle that you specify in the motion sensors file, to define the relative positions of the vehicle wheels. SimGEN calculates the relative rotation speed (pulsing frequency) of each wheel using the vehicle speed over ground at a reference location (currently, the mid-point between the wheels on the vehicle’s rear axis). In addition, SimGEN needs the location of the tachometer sensor with respect to the vehicle body in forward, right and down co-ordinates; and the drive direction (forward = 1, reverse = 0).

The origin of the vehicle body frame is located at the vehicle CofG using forward ($F_{CofG}$), right ($R_{CofG}$), down ($D_{CofG}$) axes as shown in this figure.





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The tachometer reference frame also uses forward, right and down co-ordinates with its origin located at the mid-point on the rear axle of the vehicle. The difference in frame position is a translation in the forward and down axes; moving from one frame to the other does not require rotation.

The digital data file can contain optional comments on lines beginning with '!'. The digital data file uses a header line to specify the tachometer position, in metres, with respect to the tachometer reference frame. If you do not provide the tachometer position, SimGEN assumes the tachometer is located at the centre point of the vehicle's rear axle. As in the analogue data file, the digital data file uses a separate header line to define the scenario start time that allows you to use a new start time without modifying each time-stamp.

The rest of the file consists of lines containing a time-stamp, speed over ground ($m.s^{-1}$) and drive direction for the duration of the scenario. You must use the time of applicability for the time-stamp, which is referenced to the scenario start time.

The digital data file format is:

```
!Optional comment
Vehicle tacho location wrt rear axle mid-point: {f.f, r.r, d.d}
!Optional comment
Scenario start time: {dd-mmm-yyyy hh:mm:ss}
Timestamp (sss.sss), Speed over ground, Drive direction
Timestamp (sss.sss), Speed over ground, Drive direction
.
.
```

Example digital data file, placing the tachometer 1 m forward of the mid-point of the vehicle rear axle in the horizontal plane defined by the front and rear axles:

```
! Vehicle tacho location
Vehicle tacho location wrt rear axle mid-point: {1.0, 0.0, 0.0}
! Definition of scenario start time
Scenario start time: {08-FEB-2003 12:59:59}
0.000, 12.234, 1
0.200, 12.447, 1
0.400, 12.663, 1
.
.
```

#### 21.14.3.4 Missing and spurious data

If an analogue or digital data file is missing data at a particular time-stamp, SimGEN holds the I/O card output at the value corresponding to the previous, valid, data.

If SimGEN encounters spurious data, it will discard the current record and hold the I/O card output at the most recent, valid record. This process continues until SimGEN encounters the next valid record.

#### 21.14.3.5 Synchronising SimAUTO with a signal generator

SimAUTO synchronises to the 10 millisecond update rate from GSS9000-series and GSS7000 signal generators or the earlier GSS8000-series (or the superseded GSS6560) signal generators. SimGEN calculates the data it applies to the analogue and digital I/O cards at 10 millisecond time steps.

Currently, Spirent uses an Adlink PCI-6208V card for the analogue I/O card. This card provides a bi-polar voltage range of ±10 Volts with 16-bit quantization.

In the digital I/O card, Spirent uses a buffer containing up to 20 milliseconds of data. SimGEN clocks the data at 1 MHz, which it derives from the independent clock on the output card; consequently, there is scope for the data transmission rate to drift relative to the RF simulation time reference.

#### 21.14.3.6 Messages

When using data from files, the **System Messages** window provides this information:

- → Advice that SimGEN is using data from files, rather than a motion model
- → The voltage range from the analogue data file
- → The position of the tachometer from the digital data file

This table shows the warning and error messages you may see in the **System Messages** window when using data from file with SimAUTO.

| Warnings (SimGEN continues running scenario) | Errors (SimGEN stops scenario at first error) |
|---|---|


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| Warnings (SimGEN continues running scenario) | Errors (SimGEN stops scenario at first error) |
|---|---|
| End of data file (SimGEN has read and used all available data) | Incorrect format for time data in analogue and digital data files |
| Tachometer position lies outside body perimeter | No corresponding *.umt file in scenario |
| Inconsistent start times in analogue and digital data files | Missing analogue or digital file<br>Negative start time in analogue or digital data files |

#### 21.14.3.7 Test mode

***Note**: After using the test mode, you must deselect **Enable generation of turntable rotation rate signal** before running your scenario*

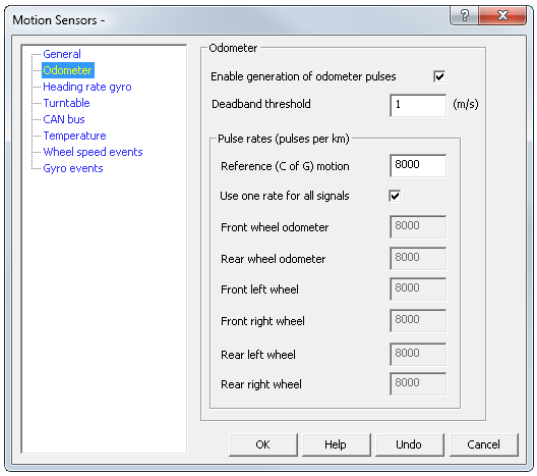
Select **Motion sensors-Turntable-Enable generation of turntable rotation rate signal** to scale the data in the analogue file from the limits defined in **Motion sensors-General-User supplied analogue / digital data-Min voltage** and **-Max voltage** to the ±10 V range the rate table uses.

Run the scenario and monitor the voltages on the analogue I/O card outputs while observing the appropriate **Vehicle Dynamics** dial in SimGEN and confirm the rate table position corresponds with the azimuth of the vehicle.

### 21.14.4 Odometer

***Note**: When connecting equipment to either of the SimAUTO output signals types, ensure the equipment under test is voltage compliant. Max/Min Analogue voltage range ±10 V.*

Configure the pulse frequency in relation to speed using the **Odometer** dialog:




| | | | |
|---|---|---|---|
| **Enable generation of odometer pulses** | Select (default): generates odometer pulses<br>Deselect: does not generate odometer pulses | | |
| **Deadband Threshold** | The value where sensors cease to generate a signal at very low speeds | | |
| | Units: metres per second | Range: 1 E-06 to 10 $m.s^{-1}$ | Default: 1 |
| **Pulse rates (pulses per km)** | Enter the sensor calibration as a figure in pulses per kilometre travelled for each sensor type. | | |
| **Reference (CofG) motion** | The reference motion for the odometer | | |
| | Units: pulses per km | Range: 100 to 100 000 | Default: 8 000 |
| **Use one rate for all signals** | Select (default): uses one pulse rate for each sensor shown<br>Deselect: set the pulse rate for each sensor shown | | |


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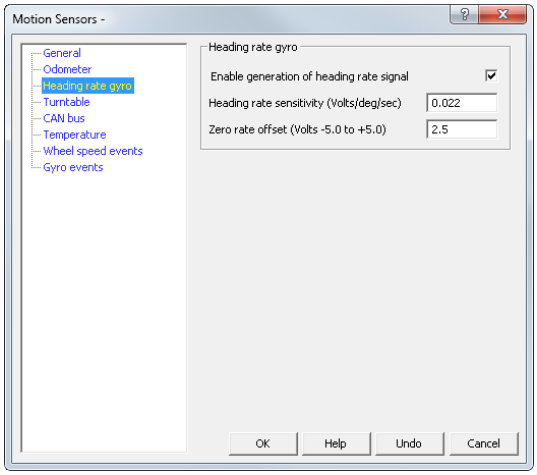
#### 21.14.4.1 Digital output signals

This table details the signals available on the cable assembly that Spirent supplies with the SimAUTO upgrade package. The cable assembly uses BNC connectors to give eight digital output signals, provided by the digital I/O card.

| Label | Signal Description |
|---|---|
| **D1** | Vehicle Centre of Gravity speed |
| **D2** | Front axle odometer speed (calculated as average of the two front wheels) |
| **D3** | Rear axle odometer speed (calculated as average of the two rear wheels) |
| **D4** | Front left wheel speed |
| **D5** | Front right wheel speed |
| **D6** | Rear left wheel speed |
| **D7** | Rear right wheel speed |
| **D8** | Forward / reverse sense 1 - Forward : 0 - Reverse<br>Reverse is the negative value of the x-component of the body velocity vector (through the nose of the vehicle), the opposite direction to the heading.<br>***Note**: Before SimGEN version 2-50, D8 was set to forward only* |

### 21.14.5 Heading rate gyro

Set the calibration figures for a simulated rate gyro using the **Heading rate gyro** dialog and selecting **Enable generation of heading rate signal**.




| | | | |
|---|---|---|---|
| **Enable generation of heading rate signal** | Select (default): generates a heading rate signal<br>Deselect: does not generate a heading rate signal | | |
| **Heading rate sensitivity** | The sensitivity of the heading rate signal | | |
| | Units: Volts per degree per second | Range: 0.001 to 10 $V.(deg)^{-1}.s^{-1}$ | Default: 0.022 |
| **Zero rate offset** | Type a calibration figure for zero rate of turn bias | | |
| | Units: Volts | Range: ± 5 V | Default: 2.5 |

#### 21.14.5.1 Heading rate as an analogue voltage

***Default analogue ports*** (page 21-44) details the analogue output ports.

You can express the heading rate as an analogue voltage using the equation:

$$R = \omega_z * \kappa_g + \delta_g$$



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Where:

$R$: Heading rate (V),

$\omega_z$: Vehicle body z-axis (down) gyro-rate (deg.s$^{-1}$),

$k_g$ : Heading rate sensitivity V.(deg)$^{-1}$.s$^{-1}$,

$\delta_g$: Zero rate offset (V).

You can get the left-right gyro-rate directly from SimGEN's Land Vehicle motion model.

For example, if $\omega_z$ = 1.0 deg.s$^{-1}$, $k_g$ = 0.099 999 9 V.(degree)$^{-1}$.s$^{-1}$ and $\delta_g$ = 0.25 V, the heading rate voltage would be:

(1.0 * 0.099 999 9) + 0.25 = 0.349 999 9 Volts.

You can check the turntable speed during a series of manoeuvres by logging Quick-Look data for $\omega_z$ (specifically, ECEF Z angular velocity, but notice the units are in rad.s$^{-1}$), see ***Quick look - Vehicle*** (page 25-3), assuming the vehicle is not pitching during the simulation. Then use the above equation to convert the data series to Volts.

### 21.14.6 Turntable

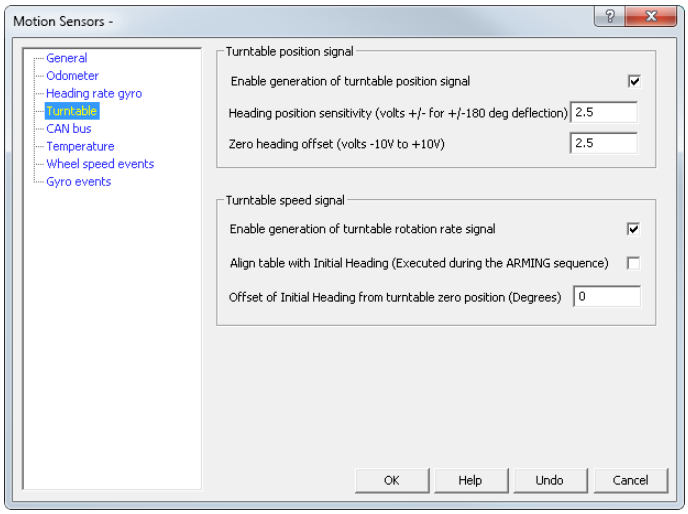
**WARNING - RATE SIGNAL**

**The turntable speed signal is a RATE signal.**
**The turntable will rotate continuously at the rate determined by the rate sensitivity.**
**You must ensure your test environment can use rate signals.**

**Before testing, discuss your proposed test environment with Spirent**

This signal has its maximum positive value when the vehicle heading is +180 degrees and its minimum value at -180 degrees.

In this figure, the signal varies between 0.0 and 5.0 volts as the vehicle turns and has a value of 2.5 volts when the vehicle is heading due North.




| | | | |
|---|---|---|---|
| **Enable generation of turntable position signal** | Select (default): generates a turn table speed signal<br>Deselect: does not generate a turn table speed signal | | |
| **Heading position sensitivity** | The sensitivity of the position signal | | |
| | Units: Volts for 180° deflection | Range: ±0.1 to 10 V for ± 180° | Default: 2.5 |
| **Zero heading offset** | Type a value for the heading output at zero degrees (due North) | | |
| | Units: Volts | Range: ± 10 V | Default: 2.5 |
| **Turntable speed signal** | | | |

| | | | |
|---|---|---|---|
| **Enable generation of turntable rotation rate signal** | Select (default): generates a position signal<br>Deselect: does not generate a position signal | | |
| **Align table with Initial Heading** | Deselect (default): does not align table<br>Select: aligns table | | |
| **Offset of Initial Heading from turntable zero position** | Unit: degree | Range: 0 to 359.9° | Default: 0 |

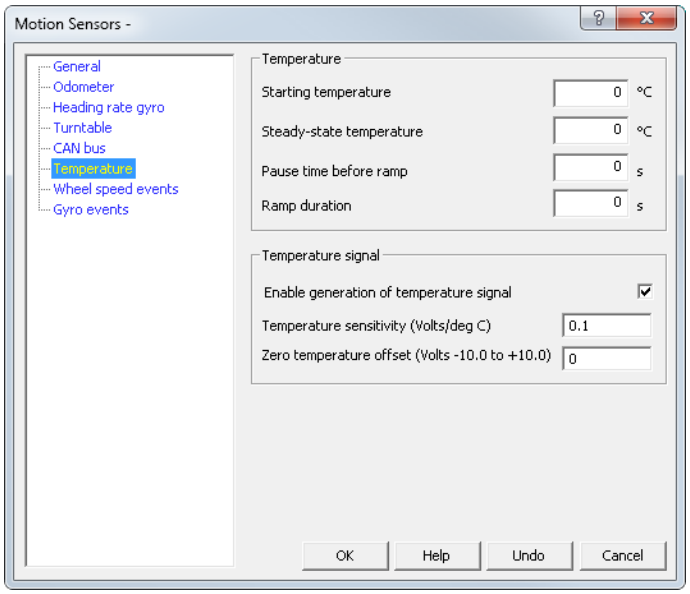
## 21.14.7 CAN bus

***Note**: Currently PosApp does not support CAN bus. Contact **Spirent Global Services** for further details.*

## 21.14.8 Temperature

***Note**: Spirent assumes the factor applied for a Gyro Bias is zero at zero temperature and applies linearly with temperature. Do not use these values as a physical temperature, but as a mechanism to parameterise the error event.*
*Spirent recommends you check the values recorded in the CMS log to ensure the temperature related errors applied match the intended values for the test.*

This figure shows the **Motion sensor-Temperature dialog**.




| | | | |
|---|---|---|---|
| **Starting temperature** | Set Starting temperature so the computed linear bias factor is correct in the 'cool' state. | | |
| | Units: degrees C | Range: 0 to 500°C | Default: 0 |
| **Steady-state temperature** | Offset the Steady-state temperature from the Starting temperature to relate to the operating 'warm' state.<br>Uses the same Units, Range and Default as **Starting Temperature** | | |
| **Pause time before ramp** | Set Pause time before ramp and Ramp duration to meet your test requirement. | | |
| | Units seconds | Range: 0 to 10 000 s | Default: 0 |
| **Ramp duration** | Units: seconds | | Default: 0 |
| **Enable generation of temperature signal** | Select (default): generates a temperature signal with the following parameters<br>Deselect: does not generate a temperature signal | | |
| **Temperature sensitivity** | Units: Volts per degree C | Range: | Default: 0.1 |


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| | | | |
|---|---|---|---|
| **Zero temperature offset** | Units: Volts | Range: -10 to +10 V | Default: 0 |

#### 21.14.8.1 Gyroscope temperature as an analogue voltage

***Default analogue ports*** (page 21-44 details the analogue output ports.

First, calculate the gyroscope's temperature (in °C), at the current time $x$, using a linear interpolation between the initial and steady-state temperature values:

$$T_i = y_0 + \left( \left( y_1 - y_0 \right) / \left( x_1 - x_0 \right) \right) * \left( x - x_0 \right)$$

Where:

$T_i$: Interpolated gyroscope temperature (°C),

$y_0$: Starting temperature (°C),

$y_1$: Steady-state temperature (°C),

$x_0$: Temperature ramp start time (s),

$x_1$: Temperature ramp end time (s).

Then, use this value of $T_i$, to express the gyroscope temperature in Volts:

$$T = T_i * \kappa_T + \delta_T$$

Where:

$T$: Gyroscope temperature (V),

$T_i$: Interpolated gyroscope temperature (°C),

$k_t$: Gyroscope temperature sensitivity (V.(°C)$^{-1}$),

$\delta_T$: Gyroscope temperature offset (V).

For example, you can calculate the gyroscope temperature as follows:

First, calculate $T_i$ using these example parameters: $X$= 3 s, $y_0$ = 0°C, $y_1$ = 60°C, $x_0$ = 2 s and $x_1$ = 12 s:

0 + ((60 - 0) / (12 - 2)) * (3 - 2) = 6° C.

Now, using $T_i$ = 6°C and these parameters: $k_t$ = 0.1 V.(°C)$^{-1}$ and $\delta_T$ = 0.1 V, we can calculate the gyroscope temperature:

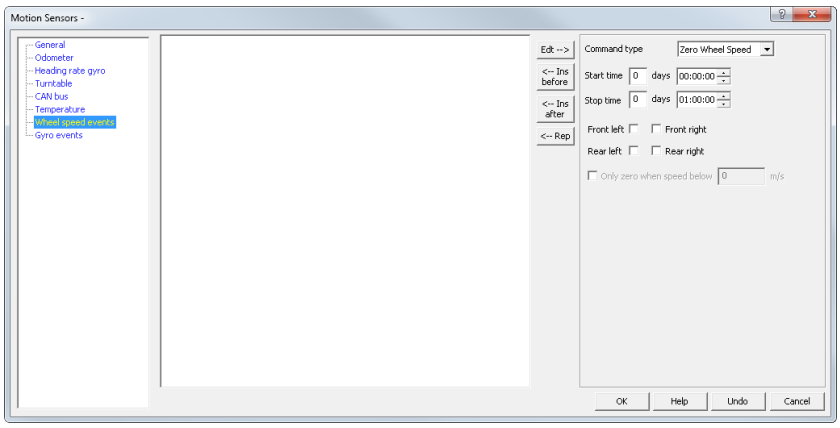
6.0 * 0.1 + 0.1 = 0.7 Volts

### 21.14.9 Wheel speed events

***Note***: *You must manually build the Command file list in the order you want. SimGEN does not automatically order these actions.*

There are three Command types, **Zero Wheel Speed**, **Algorithmic Errors** and **Faster Wheel Speed**. Create these events using the SimGEN ***List Editor*** (page 5-33):


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You can apply the Command Types separately to each wheel, by selecting the wheel from: **Front left** / **Front right** / **Rear left** / **Rear right**.

For Algorithmic Error, you can restrict the error to cases where the wheel speed is above a threshold value.

A formula intended to simulate both randomised and systematic errors computes the Algorithmic Error, applying the formula:

S = (1-alpha)S_T + beta + eta*G(seed) + (tau + tau_R*G(seed))*A_T

Where:

S is the speed error computed (this can be recorded in the CMS log),

alpha is a scale factor that simulates non-linearity,

S_T is the true wheel speed from the vehicle model,

beta simulates systematic bias in the sensor reading,

eta is a white noise factor randomised by the Gaussian factor G,

tau simulates systematic lag in the sensor reading (where the sensor under reads during acceleration and over reads on braking),

tau_R is a randomised lag in the sensor reading,

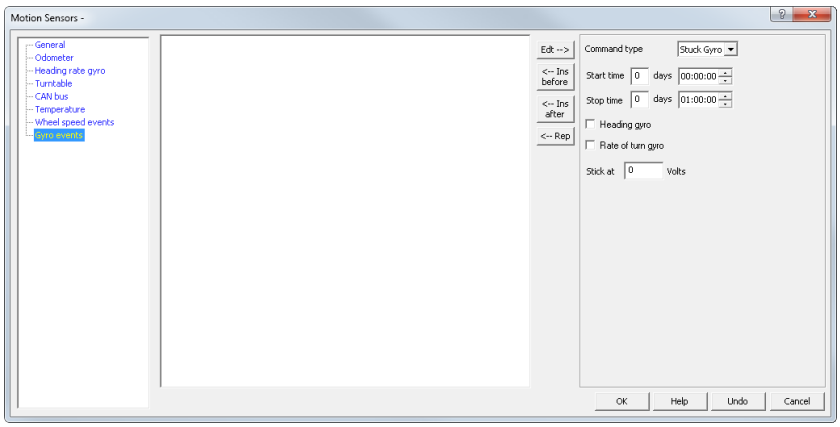
A_T is the true vehicle acceleration from the vehicle model.

## 21.14.10 Gyro events

***Note***: *You must manually build the Command file list in the order you want. SimGEN does not automatically order these actions.*

Use the SimGEN ***List Editor*** (page 5-33) to specify three **Command types** and apply these **Command types** to either or both of the analogue voltage outputs. You can set the **Gyro Noise** and **Gyro Bias** errors to apply at any temperature, or only within a specified temperature range.

You can apply simultaneous multiple events.




| | |
|---|---|
| **Stuck Gyro** | The sensor remains locked at specified value |


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| | | | |
|---|---|---|---|
| **Start time,**<br>**Stop time** | Units:<br>d hh:mm:ss | Range:<br>0 days 00:00:00<br>to 23 days 23:59:59 | Default:<br>0 days 00:00:00 |
| | Select **heading gyro** and / or **rate of turn gyro**, as appropriate | | |
| **Stick at** | Units: Volts | Range: ± 10 V | Default: 0 |
| **Gyro Noise** | Specify a value or use a value in conjunction with a temperature ramp. SimAUTO computes the noise bias from a Normal Distribution of mean mu and standard distribution sigma. | | |
| | Select **heading gyro** and / or **rate of turn gyro**, as appropriate<br>Select **Apply regardless of temperature** or **Apply only if temperature between...** (and enter the **Lower bound** and **Upper bound**) | | |
| **Lower bound**<br>**Upper bound** | Units: degrees C | Range: 0 to 500°C | Default: 0 |
| **Normal distribution - mu**<br>**Normal distribution - sigma** | Units: none | Range: 0 to 5 | Default: 0 |
| **Gyro Bias** | You can set Gyro Bias as a systematic constant value or as a value that varies with a temperature ramp. You can specify both these types of bias as simultaneous events that give a random bias super-imposed on a fixed value. | | |
| | Select **heading gyro** and / or **rate of turn gyro**, as appropriate | | |
| | Select **Apply regardless of temperature** or **Apply only if temperature between...** (and enter the **Lower bound** and **Upper bound**) | | |
| **Constant bias** | Units: Volts | Range: ± 10 V | Default: 0 |
| **Linear bias** | Units: Volt per degree C | Range: ± 10 V.$(°C)^{-1}$ | Default: 0 |

### 21.14.11 Vehicle reverse

***Note**: From SimGEN version 2-50 onwards, the Land Vehicle model uses negative speed to indicate reverse.*

You can specify speed as negative in either the **Reference** or **Acceleration** commands.

SimAUTO detects reverse by using the fact that the x-component of the body velocity vector (through the nose of the vehicle) is negative; that is, in the opposite direction to the heading.

## 21.15 SimAUTO application

***Notes**:*

***1)** You can use SimAUTO with any Land vehicle. However, in the scenario contents window, you must set **Options-Data Streaming Definition file-Vehicle n-Car motion sensor** to be the same vehicle (**Vehicle n**) you select in **Vehicle n-Options-Motion sensor file**. For example, if you select **Vehicle 3-Options-Motion sensor file**, you must select **Options-Data Streaming Definition file-Vehicle 3-Car motion sensor***

***2)** For GSS8000-series and earlier signal generators, the drivers for the third-party PCI I/O cards Spirent uses for SimAUTO only support 32-bit Windows. This means you must install SimAUTO.exe on a 32-bit machine. If you want to run SimAUTO on the same machine as SimGEN, you must install SimGEN on a 32-bit machine*

The SimAUTO application, *SimAUTO.exe*, is a stand-alone application that controls the SimAUTO PCI cards and calibrates the **Rotation rate sensitivity** and **Zero rotation rate offset** of the turntable in use. To use SimAUTO you must run *SimAUTO.exe* as well as SimGEN.

You can install the SimAUTO application on a PC other than the C50r SimGEN Host for GSS9000-series signal generators, the Embedded Host for GSS7000 signal generators (or the SimGEN Controller for GSS8000-series and earlier signal generators).

For GSS7000 signal generators running PosApp version 6-00 onwards, install SimAUTO on a remote PC as follows:

→ Navigate to the **SimAUTO** folder on your Embedded Host (*D:\posapp\software\<version>*)


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→ Copy the files *install_SimAUTO_on_remote_PC.bat* and *SimAUTO.zip*

→ Save these files to a convenient folder on the PC on which you want to run remotely run SimAUTO

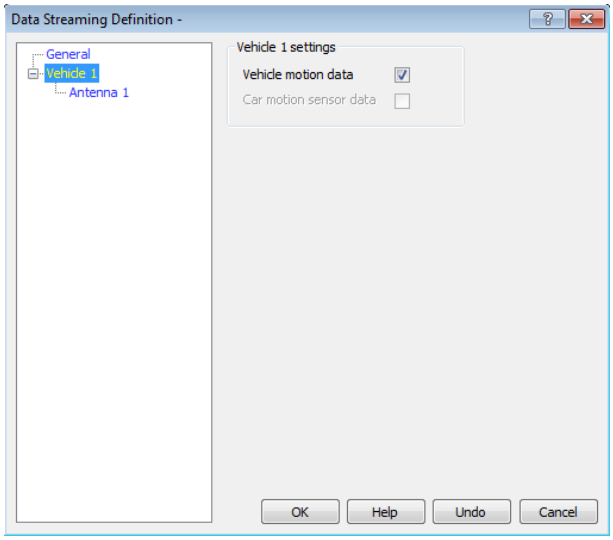
→ Double-click *install_SimAUTO_on_remote_PC.bat*.

→ This unzips the **SimAUTO** application and all required **.dll* files to the current folder and copies *simgendatastreaming.dll* file to the folder *…\System32* (for 32-bit systems) or *…\SYSWOW64* (for 64-bit systems) UNLESS the file already exists.

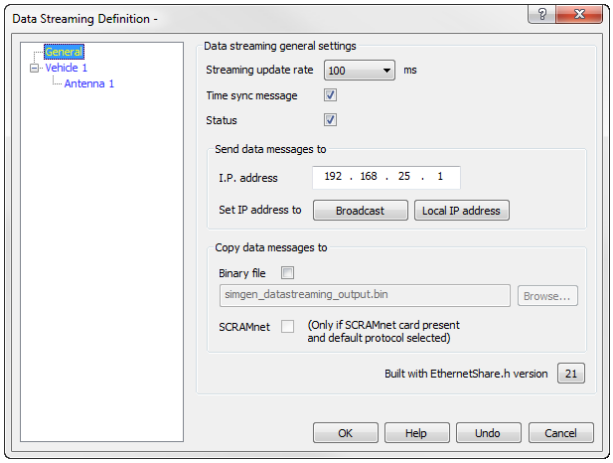
For GSS9000-series signal generators, the default location of the SimAUTO application is *D:\posapp\software\<version>*.

For GSS8000-series, and earlier, signal generators, the default location of the SimAUTO application is *C:\Program Files\Spirent Communications\Positioning Application*.

First, you must select **Options-*Data streaming definition file*-Vehicle n-Car motion sensor** (page 8-6) to ensure SimGEN sends data to the SimAUTO Application over UDP, as in this figure that shows **Vehicle 1**:

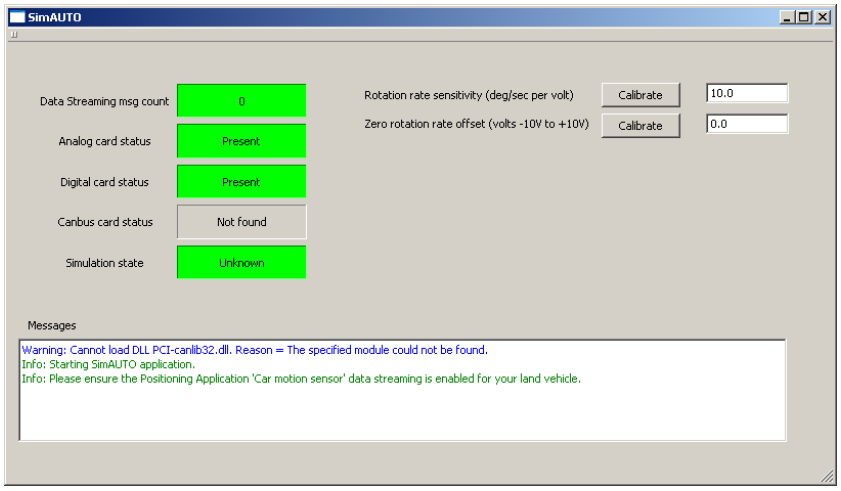



If you are using a GSS9000-series signal generator with a C50r SimGEN Host, or a GSS7000 with an Embedded Host , you must set **Options-Data Streaming Definition-General-Send data messages to-IP address** to **192.168.25.1**, see this figure:




This figure shows the SimAUTO application:


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| | | | |
|---|---|---|---|
| **Data Streaming msg count** | Displays the number of received Data Streaming messages | | |
| **Analog card status** | The SimAUTO analog card is **Present** or **Not found** | | |
| **Digital card status** | The SimAUTO digital card is **Present** or **Not found** | | |
| **Canbus card status** | The SimAUTO Canbus card is **Present** or **Not found** | | |
| **Simulation state** | Displays the PosApp simulation state | | |
| **Rotation rate sensitivity** | The sensitivity of the position signal.<br>See ***Calibrating rotation rate sensitivity*** | | |
| | Units: degrees per second per Volt | Range: ±0.1 to 10 V for ± 180° | Default: 10 |
| **Zero rotation rate offset** | Type a value for the heading output at zero degrees (due North).<br>See ***Calibrating zero rotation rate*** | | |
| | Units: Volts | Range: ± 10 V | Default: 0.0 |

### 21.15.1 Rate table calibration



**WARNING**

**The rate table will rotate continuously at the rate determined by the rate sensitivity.**

***Notes***

***1)*** *You can determine the calibration factors for* ***Rotation rate sensitivity*** *and* ***Zero rotation rate offset*** *in any order*

***2)*** *Measure the two calibration factors alternately, since each factor slightly affects the other. You must proceed iteratively until the changes in the calibration factors become insignificant.*

***3)*** *The digital to analogue converter on the analogue output card used by SimAUTO has a resolution of 0.000 3 Volts per bit.*

***4)*** *You must use the three commands shown below to 'North align' the rate table before running a scenario that uses the rate table*

Before running a scenario that uses the rate table, or before you calibrate the rate table, you must use the DriveGUI software (see reference qqq), to 'North align' the rate table. Work in the DriveGUI terminal and type the following three commands:

**OPMODE 8**
**MH**
**OPMODE 1**


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For a “full” calibration, Spirent recommends you complete the procedure in reference qqq) (DCS0037B) before calibrating the rate table.

First, select ***Turntable*-Enable generation of turntable rotation rate signal** (page 21-49) to operate the rate table.

The voltage of the rotation-rate signal must accurately demand the rate of rotation you want to achieve from the rate table.

This signal is characterised by two related factors:

- The relationship between the speed signal and the rate of rotation, see ***Calibrating rotation rate sensitivity***
- The exact voltage representing zero rate of rotation, see ***Calibrating zero rotation rate*** (page 21-57)

Calibrating the speed signal and rate of rotation is iterative. Use an initial calibration to obtain accurate calibration factors for **Rotation rate sensitivity** (degrees per second per Volt) and **Zero rotation rate offset** (zero rate of rotation). First, use the rate table settings. Refer to the rate table documentation for details on assigning an input voltage control signal.

For example, the Accutronic AC1120E rate table takes an input speed signal that varies between +10 and -10 volts and has a zero rotation-rate at approximately 0 volts.

A typical setting for this rate table would be 10 degrees per second per Volt, giving a maximum rate of 100 degrees per second at a resolution of (10 / 0.0003), or 0.003 degrees per second.

For this example, the initial calibration factors are:

**Rotation rate sensitivity**: 10 degrees per second per Volt

**Zero rotation rate offset**: 0.0 Volts.

#### 21.15.1.1 Calibrating rotation rate sensitivity

***Notes**:*

***1)** During the calibration period, the rate table must be free to rotate without restriction. Remove any cables not connected through rate table slip rings.*

***2)** A large number of rate table rotations will improve accuracy. Ten rotations will minimise errors.*

This calibration measures the time the rate table takes to rotate an integral number of rotations in each direction, after the SimAUTO application has set the rate table rotating at a known (or intended) rate. The calibration takes the average of the rotation periods in each direction.

The SimAUTO application records the time between the rate table passing a marker and, sometime later, when it passes the same marker. The SimAUTO application then sets the rate table to rotate in the other direction and the observations repeated. The SimAUTO application then calculates the calibration factor.

It is not necessary for the rate table to rotate a specific number of turns, or for the number of turns to be the same in each direction.

Determine a convenient, fixed, reference point. Then mark the rate table so you can determine its position to the reference point.

Calibration procedure:

- Click **Calibrate**. The button text changes to **Start timer**.
- The SimAUTO application commands the rate table to begin rotating clockwise.
- Observe the rate table and the reference point. As the mark on the rate table passes the reference point, click **Start timer.** The button text changes to **Stop timer**.
- Allow the rate table to make the required number of turns.
- As the rate table marker passes the reference point for the last time, click **Stop timer**. The button text changes to **Start timer**.
- The SimAUTO application commands the rate table to reverse its direction of rotation.
- The rate table rotates anti-clockwise.


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- Observe the rate table. As the rate table mark passes the reference point, click **Start timer**. The button text changes to **Stop timer**.
- Allow the rate table to make the required number of turns.
- As the rate table marker passes the reference point for the last time, click **Stop timer**. The button text changes to **Calibrate**.
- The text box to the right of the **Calibrate** button displays the calibration factor.
- The SimAUTO application commands the rate table to stop rotating.

You can abandon the calibration procedure at any time by either clicking **Cancel** or pressing the ESC key.

Save the calibration factor by clicking **OK**.

#### 21.15.1.2 Calibrating zero rotation rate

***Notes**:*

***1)** During the calibration period, the rate table must be free to rotate without restriction. Remove any cables not connected through rate table slip rings.*

***2)** There is a trade-off between high dynamics and resolution. The dynamics of the scenario may make it desirable to have different rate table settings.*

Due to the way that Digital to Analogue and Analogue to Digital converters operate, there is no true zero value. You must choose a value that is as close to zero as the digital resolution allows. Calibration of the analogue input of the rate table does not result in zero rate at zero Volts/open circuit. Without compensation, the rate table will exhibit a slow drift.

The zero rotation-rate calibration procedure involves observing the motion of the rate table while the SimAUTO application commands it to rotate at the zero rate.

Since the rate of drift may be very slow, it is necessary to conduct the measurement over a long period. Typically, 30 minutes to one hour is necessary to see a measurable movement. Enter the observed change in position while SimGEN measures the time using the clock in the C50r SimGEN Host for GSS9000-series signal generators, the clock in the Embedded Host for GSS7000 signal generators (or the SimGEN Controller for GSS8000-series, and earlier, signal generators). Dividing the change in position by the period gives the calibration factor.

The control program for the Accutronic AC1120E rate table can display rate table position in degrees, which you can use to measure the rate of drift. If the rate table you are using does not have this feature, you must make direct measurements of the rate table.

Determine a convenient, fixed, reference point. Then mark the rate table so you can determine its position to the reference point.

Calibration procedure:

- Click **Calibrate**. The button text changes to **Start timer**
- The SimAUTO application commands the rate table to begin rotating using the current value of the zero rate voltage
- Note the rate table position with respect to the reference point
- Click **Start timer**. The button text changes to **Stop timer**
- Wait until the rate table has moved a measurable number of degrees. This is likely to take 30 to 60 minutes
- Record the number of degrees the rate table has moved
- Click **Stop timer**. The button text changes to **Calculate**
- Type the number of degrees in the text box to the right of the **Calculate** button
- Click **Calculate**. After short time, the button text changes to **Calibrate**
- The text box to the right of the **Calibrate** button shows the zero rate calibration factor

#### 21.15.1.3 Rate table position as an analogue voltage

***Default analogue ports*** (page 21-44) details the analogue output ports.


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You can express the rate table position as an Analogue voltage using the equation:

$$P = \psi * \kappa_p + \delta_p$$

Where:

$P$: Rate table position/heading (V),

$\psi$: Vehicle heading (degrees, as a proportion of 180°), taken directly from the car motion model within SimGEN and represents the bearing relative to true North.

$k_p$: **Heading position sensitivity** (V for ±180° deflection),

$\delta_p$: **Zero heading offset** (V).

You can get the vehicle heading directly from SimGEN's Land Vehicle motion model. It represents the bearing relative to true North.

For example, a vehicle initially travelling East ($\psi$ = 90/180), with $k_p$ = 10.0 V and $\delta_p$ = 1.25 V gives a rate table position of:

(90/180) * 10.0 + 1.25 = 6.25 Volts.

The rate table position during a series of manoeuvres can be checked by first logging Quick-Look data for $\psi$ (Heading in rad), see ***Quick look - Vehicle*** (page 25-3), and then using the above equation to convert the data series to Volts.

#### 21.15.1.4 Rate table speed as an analogue voltage

***Default analogue ports*** (page 21-44) details the analogue output ports.

You can express the rate table speed as an analogue voltage using the equation:

$$S = \omega_z * \frac{1}{\kappa_s} + \delta_s$$

Where:

$P$: Rate table speed (V)

$\omega_z$: Vehicle body z-axis (down) gyro-rate (deg.s$^{-1}$)

$k_s$: **Rotation rate sensitivity**, see ***Rate table calibration***

$\delta_s$: **Zero rotation rate offset**, see ***Rate table calibration***

You can get the left-right gyro-rate directly from SimGEN's Land Vehicle motion model.

For example, let $\omega_z$ = 1.0 deg.s$^{-1}$, $k_s$ = 9.900 990 099 degrees.s$^{-1}$.V$^{-1}$ and $\delta_s$ = 1.1 V. This equation gives the initial rate table speed in Volts:

1.0 * (1/9.900 990 099) + 1.1 = 1.201 V

You can check the rate table speed during a series of manoeuvres by logging Quick-Look data for $\omega_z$ (specifically, ECEF Z angular velocity, notice the units are rad.s$^{-1}$) see ***Quick look - Vehicle*** (page 25-3), and assuming the vehicle is not pitching during the simulation. Then use the above equation to convert the data series to Volts.

## 21.16 Land mobile multipath

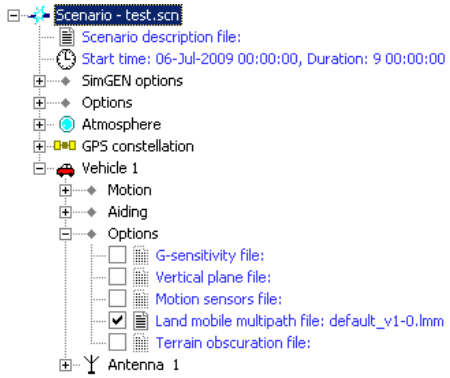
***Note**: SimGEN sets the multipath signal OFF in the one second (typically 0.6 seconds) before the off time you specify. This ensures sufficient time to load new data to the signal generator channel.*

The Land mobile multipath (LMM) model simulates the effects of multipath signals on a mobile phone incorporating GNSS positioning - see reference ff) for more details. You can use the LMM model with both **Static** and **Land vehicle** models. Typically, the worst-case multipath environment is a high-rise, urban environment; but the LMM model can also simulate environments that are more benign.

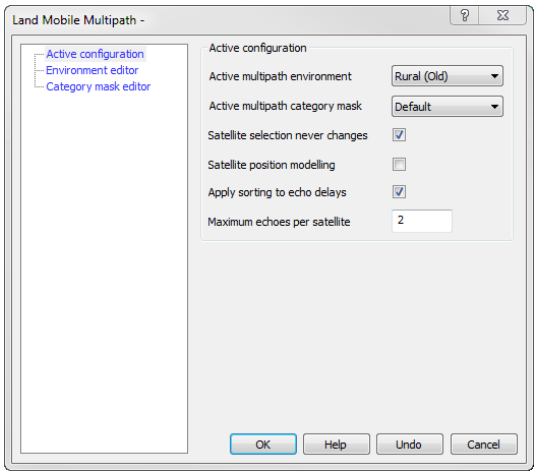

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## 21.16.1 Using the land mobile multipath model

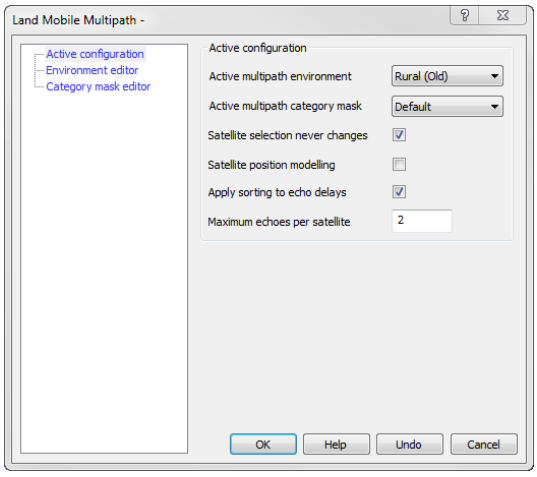
When you select **Vehicle-Static vehicle**, or **Vehicle-Land vehicle**, you can also select **Options-Land mobile multipath model** to include the **Land Mobile Multipath model** in the scenario. This figure shows **Static vehicle-Options-Land mobile multipath model**.




Double-clicking on **Options-Land mobile multipath model** opens the **Land mobile multipath** editor:




### 21.16.1.1 Active Configuration




**Active Configuration** displays the selected **Active multipath environment** and **Active multipath category mask**. The current selections define the environment and mask that apply at the start of the scenario - the figure above shows **Active multipath environment-Rural (Old)** and **Active multipath category mask-Default**. You can change these selections while a scenario is running by using either the menu item **Options-*User Actions Recording*** (page 5-30); or SimREMOTE - see reference qq).

Select the ***Environment editor*** (page 21-60) or the ***Category mask editor*** (page 21-63) to view or edit the settings.

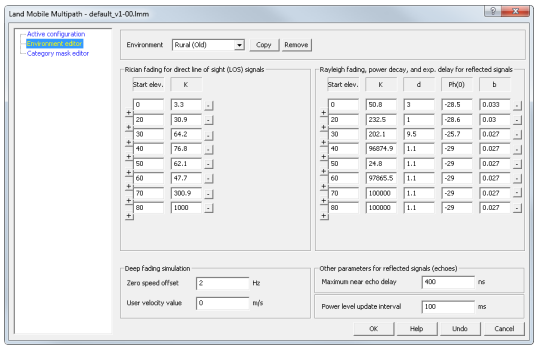

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| | | | |
|---|---|---|---|
| **Active multipath environment** | Select the multipath environment you want to use at the start of the scenario | | |
| **Active multipath category mask** | Select the mask you want to use at the start of the scenario | | |
| **Satellite selection never changes** | Select (default): prevents re-allocation of the simulated satellite set that SimGEN establishes at the start of the run.<br>This ignores satellites that rise or set during the run.<br><br>Deselect: determines a new set of simulated direct and echo signals at the update interval you define in the constellation definition file.<br>Resets all new and retained echo signals.<br>The retained echo signals will have different power level and delay characteristics from those previously in effect. | | |
| ***Note***: *SimGEN produces a fatal error if one of the simulated satellites goes out of view after selecting* ***Satellite selection never changes***. | | | |
| **Satellite position modelling** | Deselect (default): fixes the echo delays during the run.<br>Select: does not fix the echo signal delays during the run or until revision of the set of simulated signals.<br>***Rayleigh fading model*** (page 21-62) determines the initial delay. It is limited according to the satellite elevation. Subsequently, changes in satellite azimuth and elevation modify the delay for both code and carrier. | | |
| **Apply sorting to echo delays** | Select (default): Sorts echo delays in ***Received Signals*** (page 3-7) as shortest first<br>Deselect: Does not sort echo delays | | |
| **Maximum echoes per satellite** | Type the maximum number of echoes (multipath signals) per satellite that SimGEN models and displays in ***Received Signals*** | | |
| | Units - none | Range: 1 to 16 | Default: 2 |

### 21.16.1.2 Environment editor

***Note****: SimGEN re-numbers the Environments after you create a new one. If you use SimREMOTE to change the Environment during the scenario, Spirent recommends you use this editor to determine the number of the Environment you want to use before creating the SimREMOTE command.*

Use this editor to define the characteristics of the Rician and Rayleigh reflected signals as a function of satellite elevation. The following sections describe the Rician and Rayleigh fading models.




This table shows the units for each parameter in the Environment editor

| Parameter | Description (Units) |
|---|---|
| **Elevation** | Elevation (degrees) |
| **K** | Ratio of direct to multipath power received (none) |
| **d** | Power decay (dB.µs-1) |
| **Ph(0)** | Echo power for zero echo delay (dB) |


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| Parameter | Description (Units) |
|---|---|
| **b** | Exponential delay (µs) |

Look-up tables control the operation of this multipath model. SimGEN updates the signal characteristics you set in the menu item **Options-*General Options*-Simulation iteration rate** (page 5-15). The satellite elevation changes at the **Sampling interval**, set in the **Satellite selection** dialog for the appropriate constellation, with exceptions for **Land mobile multipath-*Environment editor*-Power level update interval** in ***Rician fading model*** (page 21-61) and ***Rayleigh fading model*** (page 21-62).

After using the editor to modify Environment parameters, save the changes to the current Environment (name shown in the **Environment** text area) by clicking **OK**; or save the Environment under a new name by clicking in the **Environment** text area and typing a new name. If you use SimREMOTE to change the Environment during a scenario, see the Note above.

#### 21.16.1.2.1 Rician fading model

The Rician model describes the fading on line-of-sight signals and determines the signal level offset as a random value from a Ricean distribution:

$$f_{Rician}(v) = 2Kv\exp\left[-K(v^2+1)\right]I_0(2Kv) \qquad v \geq 0$$
$$f_{Rician}(v) = 0 \qquad v < 0$$

Where:

$v$ is the received signal amplitude relative to the direct path

$K$ is the ratio of direct to mean multipath power received, user-defined

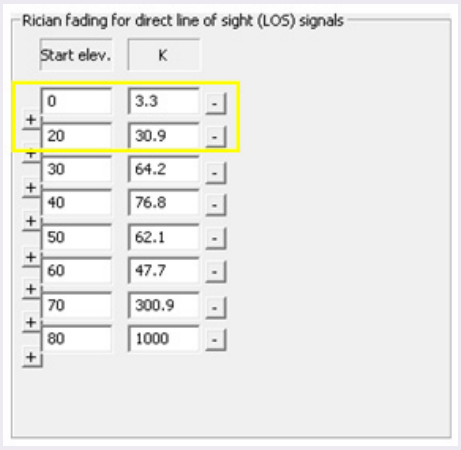
$I_0$ is the 0th order modified Bessel function of the first kind

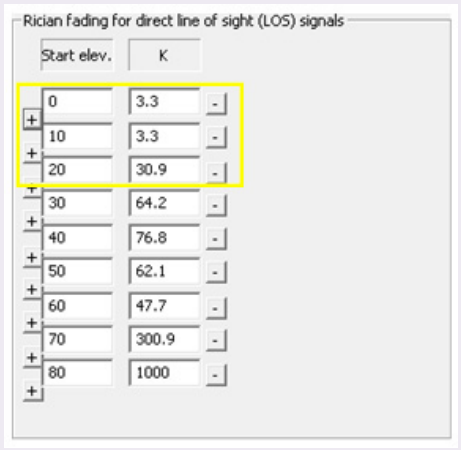
The amplitude noise on the line-of-sight channel is determined at an iteration period you define using **Power level update interval**.

This model determines a random value for $v$ and applies the change in signal level offset using $20log_{10}(v)$ dB.

| | | | |
|---|---|---|---|
| **Start elevation** | All four environments use the same default steps in **elevation**.<br>Click the **+** button to add a new elevation step at half the difference of the upper and lower **+** buttons, see the highlight in the following two figures. Click the **-** button next to a **Start elevation** to remove that **Start elevation**. | | |
| | Units: degrees | Range: 0 to 90° | Default: depends on **Environment** |
| $K$ | Each elevation step has a value of $K$.<br>Click on the **+** button to add a new elevation step at half the difference of the upper and lower **+** buttons, see the following two figures. This retains the value of $K$ for the lower numerical value of start elevation (this is the value for the higher button). | | |


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| | | | |
|---|---|---|---|
| Power level update interval | Power level update interval must be a multiple of, and not less than, the setting you use in menu item **Options-*General Options*-Simulation iteration rate** (page 5-15). Using a non-multiple value leads to undesirable results. For example, if the Simulation iteration rate is 100 milliseconds and you set Power level update interval to 80 milliseconds the power level will update every 800 milliseconds. | | |
| | Units: milliseconds<br>Minimum: 10 ms<br>Resolution: 10 ms | Must be equal to the **Simulation iteration rate**, or a multiple of it | Default:<br>100 ms |

Click **OK** to save the changes you make.

### 21.16.1.2.2 Rayleigh fading model

This is a modified Rayleigh model that describes fading on echo (multipath) channels using these three functions:

**1) Deterministic mean power reduction in addition to Rayleigh noise**

Using this function :

$$P_h(\tau) = P_h(0) - d \cdot \tau \text{ dB}$$

Where:

The Rayleigh look-up table provides $P_h(0)$ and $d$

$\tau$ is the multipath delay in seconds

**2) The amplitude noise on the echo channel**

SimGEN determines this at an iteration period you define using ***Environment editor*** (page 21-60)**-Power level update interval**.

SimGEN randomly calculates this from the following Rayleigh distribution:

$$f_{Rayleigh}(v) = 2Kv\exp\left[-Kv^2\right]$$

**3) The delay on the echo channel**

SimGEN calculates this at random with the exponential distribution shown below. This delay is constant throughout the scenario for the relevant satellite:


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$$f\exp(T)=\left[\frac{1}{b}\right]\exp\left[\frac{-T}{b}\right]$$

Where the Rayleigh look-up table provides $b$.

***Environment editor*** (page 21-60)**-Maximum near echo delay** imposes an upper limit on this delay. When the satellite is unchanged and you have not selected **Active configuration-Satellite position modelling**, this delay remains fixed.

| | | | |
|---|---|---|---|
| **Power level update interval** | Must be a multiple of, and not less than the setting you use in menu item **Options-*General Options*** **-Simulation iteration rate** (page 5-15).<br>Using a non-multiple value leads to undesirable results. For example, if the Simulation iteration rate is 100 milliseconds and you set Power level update interval to 80 milliseconds the power level will update every 800 milliseconds. | | |
| | Units: milliseconds<br>Minimum: 10 ms<br>Resolution: 10 ms | Must be greater than or equal to the **Simulation iteration rate**<br>Must be a multiple of the **Simulation iteration rate** | Default: 100 |
| **Maximum near echo delay** | Imposes an upper limit on the calculated delay.<br>When the satellite is unchanged and you have not selected **Active configuration-Satellite position modelling**, the calculated delay remains fixed.<br>If the sampled delay value is greater than the value you enter, SimGEN discards this value and determines a new value. | | |
| | Units: nanoseconds | Range: 0 to 10 000 ns | Default: 400 |

#### 21.16.1.2.3 Deep fading simulation

On all echoes (multipath signals) apart from the primary echo, SimGEN applies a carrier Doppler offset (deep fade effect), calculated using:

$$\Delta f_{carrier}(v)=B+\frac{v.\cos\alpha_e}{\lambda_{L1}}$$

Where:

| | | | |
|---|---|---|---|
| $v$ | The velocity you specify for the scenario, it is independent of the receiver motion | | |
| | Units: metres per second | Range: ± 1 000 $m.s^{-1}$ | Default: 0 |
| $B$ | The frequency offset with zero receiver velocity | | |
| | Units: Hertz | Range: 0 to 100 Hz | Default: 2 |
| $\alpha_e$ | The satellite elevation angle | | |
| $\lambda_{L1}$ | The wavelength of the GPS L1 signal | | |

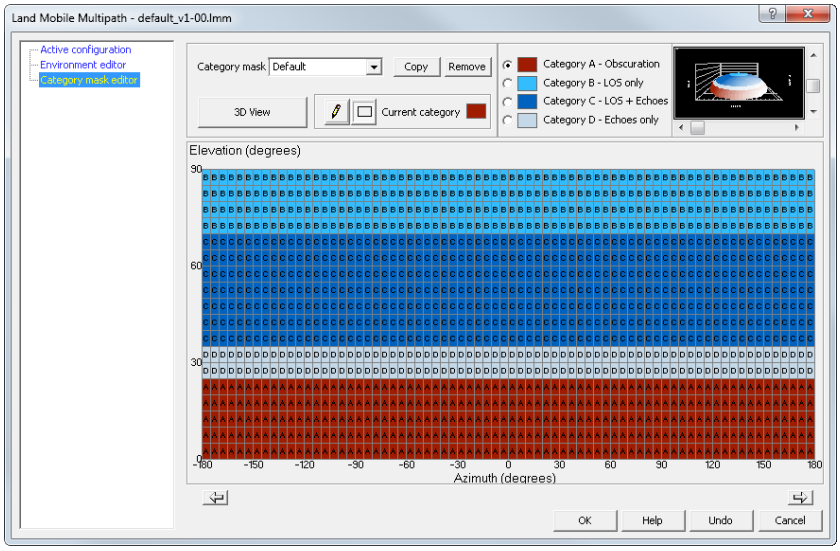
This offset is fixed during the scenario. SimGEN applies a constant range-rate carrier offset over each hardware update interval by determining the carrier range offset value at the update time.

### 21.16.2 Category mask editor

***Note****: SimGEN re-numbers the Category masks after you create a new one. If you use SimREMOTE to change the Category mask during the scenario, Spirent recommends you use this editor to determine the number of the Category mask you want to use before creating the SimREMOTE command.*


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Use this editor to edit existing category masks or add new ones:




SimGEN uses four categories of signal, determined by signal arrival angles. You can independently apply each category for different test cases. The editor briefly describes each Category in the top right-hand corner, near the 3-D image of the mask.

SimGEN resolves arrival angle into satellite elevation and azimuth in 5-degree increments for positive elevations only.

The reference frame is local geographic and the orientation of the hemisphere SimGEN creates may be rotated in the azimuth plane.

### 21.16.2.1 Category A

SimGEN does not simulate satellites arriving at these segments, so this category represents a visibility mask. It automatically excludes all satellites with elevation angles less than 5 degrees.
SimGEN allocates segments with this category to simulate:

- Obstructions at low elevation angles at particular azimuth angles, for example, simulating adjacent buildings, or
- Obstructions at high elevations, such as simulating use in a tall building

Using these segments maximises use of the available channels for meaningful signal simulation.

### 21.16.2.2 Category B

SimGEN simulates satellites arriving at these segments with a line-of-sight (LoS) signal only. The LoS signals represent generally unobstructed signals, not subject to reflections.

Satellites within category B suffer Rician fading.

### 21.16.2.3 Category C

SimGEN simulates satellites arriving at these segments as LoS plus multipaths, depending on the number of available channels. These signals represent unobstructed signals, subject to reflections.

Satellites within category C suffer Rician fading on the LoS channel and modified Rayleigh fading on the multipaths.

### 21.16.2.4 Category D

SimGEN simulates satellites arriving at these segments as multipaths only, depending upon the number of available channels. These signals represent obstructed LoS signals, present as reflections only.

Satellites within category D suffer modified Rayleigh fading on the echoes.

### 21.16.2.5 Channel allocation

Channel allocation starts with satellites at the lowest elevation angles. SimGEN allocates one channel for the lowest elevation satellite, then the next lowest satellite and so on.

Where you define both LoS and multipaths, SimGEN first allocates the LoS. This process continues until allocation of the satellite with highest elevation. The process then repeats from the lowest elevation, visible, satellite until SimGEN allocates all channels.


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Where a satellite has more than one multipath simulated, SimGEN applies the fading on each channel independently and applies a different range of allowable multipath delay, derived from a look-up table.

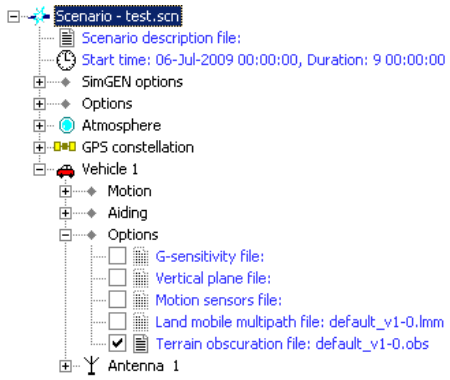
## 21.17 Terrain obscuration file

You can use SimGEN's terrain obscuration model in conjunction with terrestrial motion to simulate the effect of various types of terrain, or other categories of obstruction, interfering with the satellite signals. The terrain obscuration model is dynamic, so the effects and characteristics of the simulated obstacles will change according to the relative vehicle motion.

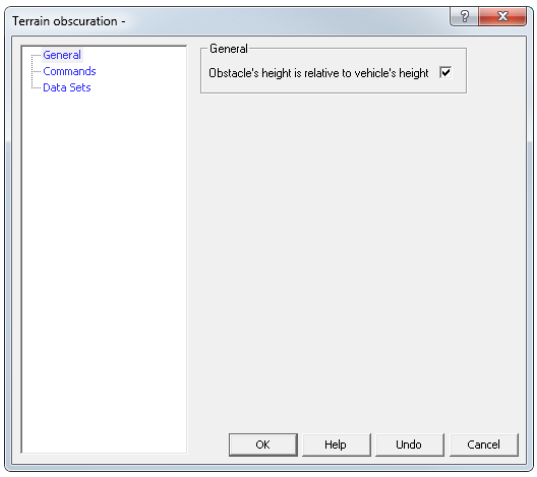
The terrain obscuration model is a simple implementation, where the same obstacle properties apply in all directions in azimuth with respect to the vehicle position, at any given time. The satellite visibility criterion is omni-directional in this context. SimGEN applies additional signal attenuation as either zero or in full.

The model allows you to place obstacles in different categories (different heights, width and distance) at various points along the simulated route of the vehicle. You can define an element of randomness in the characteristics of individual obstacles within these categories and this is repeatable run-to-run. As the vehicle moves past each obstacle, the obstacle height and distance from the vehicle determines the general satellite visibility in terms of the minimum satellite elevation angle that SimGEN may use. The vehicle speed and obstacle width determine the period over which SimGEN applies each obstacle.

Select **Vehicle model-Options-Terrain obscuration file**. SimGEN uses the default file *default_vx-yy.obs*.




Double-clicking on **Terrain obscuration file** opens the SimGEN ***List Editor*** (page 5-33), see the figure below.




The default selection of **General-Obstacle's height is relative to vehicle's height** means the terrain remains at a fixed height, relative to the aircraft.

Deselect **Obstacle's height is relative to vehicle's height** to use absolute obstacle heights, so that as the vehicle climbs above the terrain, the terrain obscures fewer satellites.

When SimGEN is not applying terrain obscuration, it simulates all satellites whose elevation is above the value of the Earth obscuration angle, set in, for example, **GPS-*Earth obscuration*** (page 10-11), at their modelled (unobstructed) power levels, assuming your signal generator has sufficient hardware channels.

Scenarios using the terrain obscuration model provide simulations that are more realistic for Aircraft receivers in hilly or mountainous areas, or Land Vehicle receivers in city streets.

The terrain obscuration model uses the following parameters:

→ The horizontal distance between the vehicle and the obstacle


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→ The randomised obstacle height, between a minimum and maximum

→ The randomised obstacle width, between a minimum and maximum

When SimGEN obscures a satellite, it attenuates the signal from that satellite to its minimum level. SimGEN does not re-allocate that satellite's signal generator channel. If SimGEN does not obscure a satellite, the signal generator continues to produce a time-coherent signal.

## 21.17.1 Terrain obscuration file-Commands

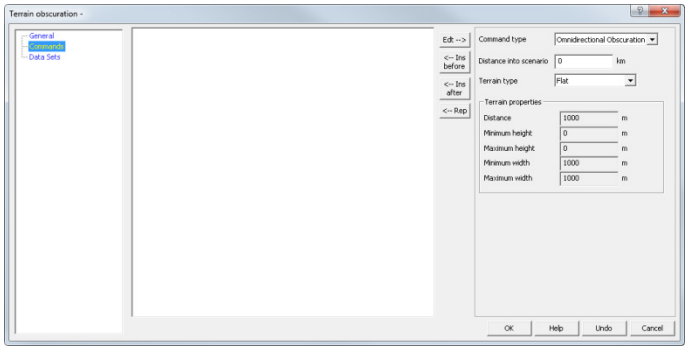
***Notes**:*

***1)** Currently only **Command Type-omnidirectional obscuration** is available.*

***2)** Saving the file removes duplicate entries.*

***3)** You must manually build the Command file list in the order you want. SimGEN does not automatically order these actions.*

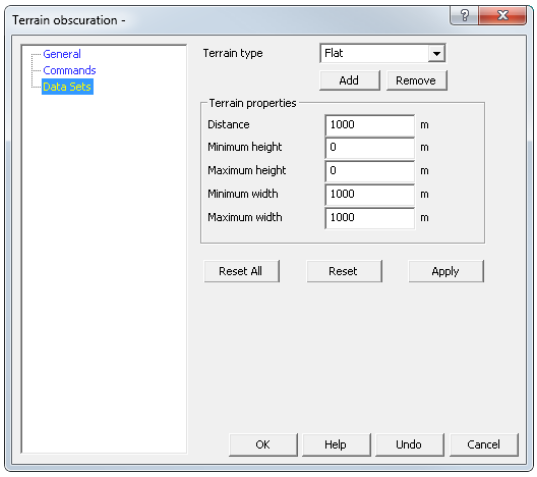
This allows you to use the Terrain obscuration ***List Editor*** (page 5-33) to define a list of obscuration commands that SimGEN will apply during a scenario.




Type the distance the vehicle travels before encountering the terrain in **Distance into scenario** and select a **Terrain Type** from the drop-down list. The **Terrain properties** area shows the characteristics of the **Terrain type**. ***Terrain obscuration file-Data Sets*** (page 21-66) details editing **Terrain properties** or creating custom terrain types.

## 21.17.2 Terrain obscuration file-Data Sets

Use **Terrain obscuration-Data sets** to edit or define each **Terrain type**.



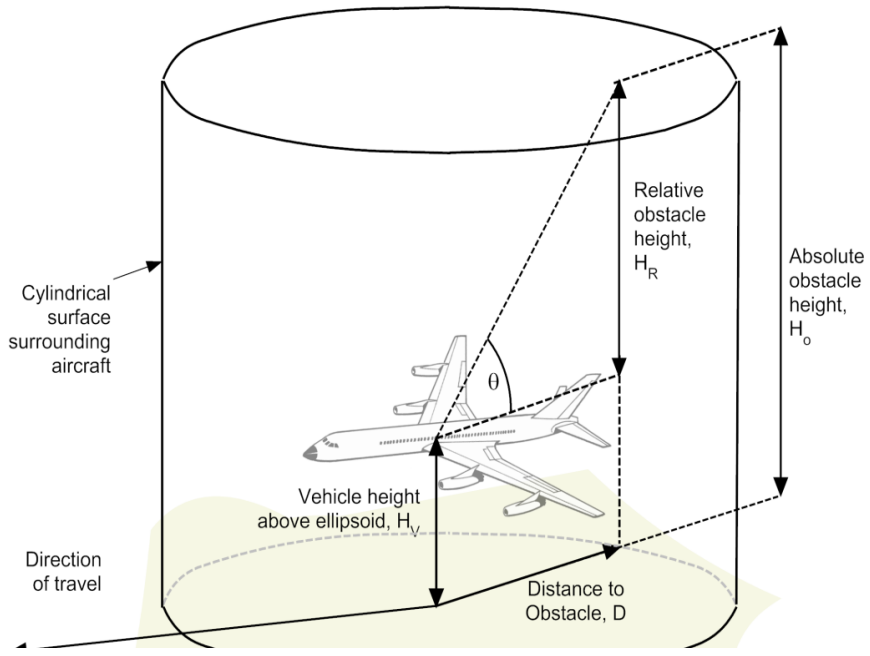

| | |
|---|---|
| **Terrain type** | Choose from the eight default and two user terrains.<br>You can rename a **Terrain type** by over-typing a new name and clicking Apply. You can add a new category by clicking Add, typing the category name and clicking Apply. Delete a category name by selecting it and clicking Remove.<br>***Note**: These names define the timed list of terrain types SimGEN uses during the scenario. Deleting existing types could give unexpected results.* |


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| | | | |
|---|---|---|---|
| **Terrain properties** | Defines the **Terrain type** parameters<br>SimGEN uses these parameters to determine obscuration angle. | | |
| **Distance** | Units: metres | Range: 0.000 to 40 000 m | Default: 1 000 |
| **Minimum height**<br>**Maximum height** | SimGEN selects the current obstacle height pseudo-randomly between **Minimum height** and **Maximum height** each time an obstacle width period is completed. | | |
| | Units: metres | Range: 0.000 to 40 000 m | Default: 0 |
| **Minimum width**<br>**Maximum width** | **Minimum width** and **Maximum width** randomly determine the width of the next obstacle for the current **Terrain type**. The vehicle speed determines the time for which this obstacle applies. | | |
| | Units: metres | Range: 0.000 to 40 000 m | Default: 1000 |

## 21.17.3 Application of Terrain obscuration

This figure shows a typical terrain obscuration model using an aircraft.




The default selection of **General-Obstacle height is relative to vehicle height** sets obstacle height as independent of the vehicle motion. The following formula gives the obscuration angle, θ. SimGEN compares this angle to the elevation angle of all currently simulated satellites and attenuates any with a lower elevation, regardless of the arrival azimuth angle. The obscuration angle, θ, is given by:


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$$\theta = a\tan\left(\frac{H_o}{D}\right)$$

Where:

$H_O$ is the absolute obstacle height

$D$ is horizontal distance from the vehicle to the obstacle

Deselecting **General-Obstacle height is relative to vehicle height** sets the obscuration as a function of the effective height difference between the vehicle and the obstacle and this formula gives the elevation angle, θ:

$$\theta = a\tan\left(\frac{H_R}{D}\right)$$

Where:

$H_R = H_o - H_v$ is the relative height of the obstacle with respect to the vehicle

$D$ is the horizontal distance from the vehicle to the obstacle

In this case, as the vehicle's height approaches the obstacle height, the incidence of obscuration decreases progressively to zero. When the vehicle is higher than the obstacle, changes in vehicle height have no effect on the pattern of the obscuration. To provide realistic simulation of intermittent obscuration, each **Terrain type** defines the parameters **Minimum height** / **Maximum height** and **Minimum width** / **Maximum width**. The essential feature of this scheme is that execution of a trajectory at different speeds repeats the obscuration pattern at an appropriately different rate. This simulates a vehicle travelling through the same terrain but at a different speed.


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# 22 INS error models

***Licenced feature**: You will need a licence to use this feature. Contact Spirent for licencing details.*

***Note:** The currently available modes of operation are the remote models SimINERTIAL and SimEGI, and the Space-Stabilised local model.*

You can assign up to four separate INS models to each vehicle you define in your scenario. Specify the type of INS you want to use, together with the appropriate characteristics and error terms for system components (such as gyros and accelerometers) using the INS model file (**.imu*).

Although you can specify different types of INS and modes of operation, they essentially fall into two main categories:

- The INS model runs in the local SimGEN environment, propagating the INS solution through the run and generating appropriate output (data streaming) messages for the emulated INS system.
- SimGEN acts as a placeholder (and means of data entry) for the INS model file, while the INS model itself runs on a remote PC. The remote PC accesses information from the model file using a remote command, as in the case of SimINERTIAL, which also uses streamed data from SimGEN.

Reference oo) gives details on SimINERTIAL. For details on the SimINERTIAL data capture tool, SimDATA - see reference pp).

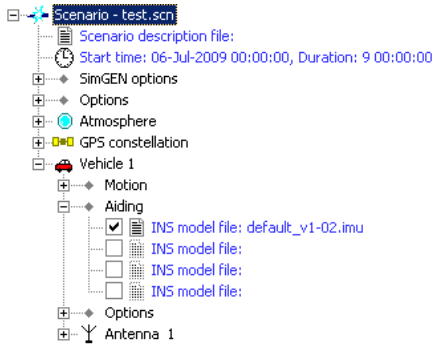
Reference bbb) describes using SimSENSOR.

In both of the above cases the implementation of a strapdown type INS model could be limited to just duplicating the sensor outputs (with errors), as is the case for SimINERTIAL. This is appropriate when testing IGI systems, where the simulated sensor data and RF signals replace real-world data.

To cause divergence of the navigation solution, both the intrinsic and remote INS models need to apply suitable sensor error models. Spirent implements this in SimGEN and SimINERTIAL using *INS Sensor Model.dll*. The dll functions use the vehicle motion (or more precisely, that applicable at the position of the aiding source) in conjunction with applicable gravity and Earth rotation effects, to determine the appropriate sensor outputs. This output includes the effects of sensor errors as defined by sensor error models. Spirent uses the sensor error models given in Stanag 4572.

SimGEN defines output messages for the baro-altimeter model within the framework of the INS model, which you use in conjunction with SimINERTIAL.

Expand **Vehicle-Aiding** to show four sets of **INS model file**. You must select at least one **INS model file** to run the INS model and you must ensure a tick is present in the checkbox, as shown below:




Highlight and double-click **INS model file** to open the INS model editor and set the parameters for each INS model you want to use. This table details the sections describing each INS model parameter.

| Parameter |
|---|
| ***General*** (page 22-2) |
| ***Aiding offset*** (page 22-5) |

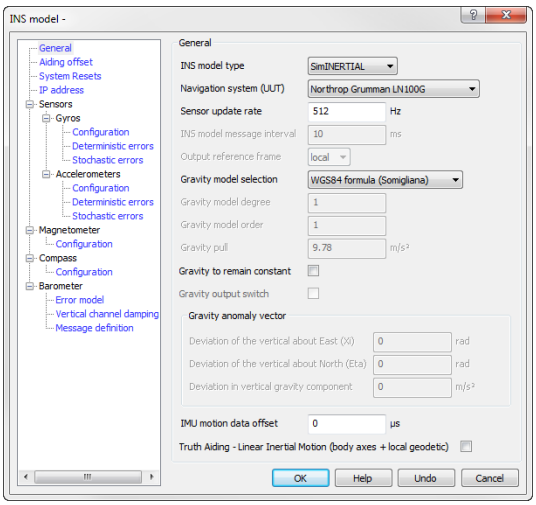

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| Parameter |
|---|
| ***System resets*** (page 22-5) |
| ***IP address*** (page 22-6) |
| **Gyros-*Configuration*** (page 22-7) |
| **Gyros-*Deterministic errors*** (page 22-8) |
| **Gyros-*Stochastic errors*** (page 22-10) |
| **Accelerometers-*Configuration*** (page 22-11) |
| **Accelerometers-*Deterministic errors*** (page 22-11) |
| **Accelerometers-*Stochastic errors*** (page 22-11) |
| ***Barometric height*** (page 22-19) |

***INS sensor error model*** (page 22-21) details the sensor error model.

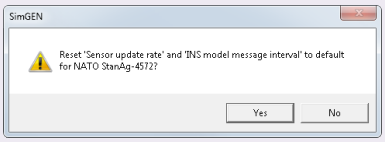
## 22.1 General

This figure shows the **INS model-General** dialog. Use this dialog to select the INS model you want to use.




| | |
|---|---|
| **INS model type** | Choose from: |
| **SimINERTIAL** | ***Licenced feature**: You will need a licence to use this feature. Contact Spirent for licencing details.*<br><br>SimGEN defines the INS (IMU) characteristics, but it runs on a remote PC. Use the remote command GET_INS_FILE to access information in the INS model file before the start of the run.<br>During the run, the remote PC obtains motion data from SimGEN using the streamed data message Truth Aiding EGI.<br>**SimINERTIAL** automatically enables Truth Aiding EGI<br>Enables: **Navigation system (UUT)**, **Gravity to remain constant** and **IMU motion data offset**<br>Disables: **INS Model message interval**, **Output reference frame**, **Gravity output switch** and the **Gravity anomaly vector** area. |


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| | |
|---|---|
| **Strapdown** | ***Licenced feature**: You will need a licence to use this feature. Contact Spirent for licencing details.*<br><br>The Strapdown model determines the delta data and then integrates it to give the datastreamed INS solution (INS Error Model).<br>Reference oo) describes the output message formats.<br>After selecting this model, you will see in this dialog.<br>  <br>Click **Yes** to use these default settings for StanAg-4572:<br>**Sensor update rate**: 200 Hz<br>**INS model message interval**: 5 milliseconds<br>Enables: **INS model message interval**, Output reference frame, Gravity anomaly vector (**Xi** and **Eta**) and **IMU motion data offset**<br>Disables: **Navigation system (UUT)**, Gravity output switch and Gravity anomaly vector- **Deviation in vertical gravity component**. |
| **Space stabilised** | ***Licenced feature**: You will need a licence to use this feature. Contact Spirent for licencing details.*<br><br>An automatically enabled, internal SimGEN model that generates data streaming messages containing the generated INS navigation solution (INS Error Model).<br>Reference qq) describes the output message formats.<br>Enables: **INS Model message interval**, Output reference frame, Gravity output switch and the Gravity anomaly vector area.<br>Disables: **Navigation system (UUT)**, **Gravity to remain constant** and **IMU motion data offset** |
| **SimEGI** | ***Licenced feature**: You will need a licence to use this feature. Contact Spirent for licencing details.*<br><br>SimINERTIAL supersedes SimEGI.<br>Spirent includes details here for backward compatibility.<br>The data defined in the INS model file has no relevance to SimEGI and this manual does not discuss SimEGI. |
| **Internal IMU** | ***Licenced feature**: You will need a licence to use this feature. Contact Spirent for licencing details.*<br><br>Before running SimGEN, fit the dongle Spirent supplies into a USB port on the SimGEN Controller to access **Internal IMU** and its parameters.<br>Outputs IMU data over Ethernet to the address you specify in the UDP protocol. SimGEN will time-stamp the IMU data with the scenario time and the time of validity of the data. Each data-packet represents the inertial data for one delta-data epoch. SimGEN transmits the data in real-time, one time step in advance, at the simulation update rate. If the IMU update-rate is higher than the simulation update rate, SimGEN transmits more than one data-packet on each simulation update. For example, if the IMU iteration rate is 500 Hz and the simulation update rate is 100 Hz, SimGEN transmits five separate data packets every simulation update (10 milliseconds) for each INS model you enable.<br>For more details, see the section on IMU_data structure in reference qq). |
| **Navigation system (UUT)** | Choose a specific system from the drop-down list to automatically assign configuration data |

***Notes***

***1)** Some parameters use pre-defined data that you cannot change, or the parameters are not applicable and disabled.*

***2)** Some of the sensor configuration parameters (scale factor and attitude) use pre-defined data that you can change.*


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| | | | |
|---|---|---|---|
| **Sensor update rate** | **Using SimINERTIAL**<br>Sets the output message rate it applies to the remote system.<br>This rate is pre-defined for certain systems.<br>**Using other INS models**<br>In conjunction with **INS Model message interval**, sets the iteration rate of SimGEN's navigation algorithm.<br>Adjusts the update time of the model to ensure there is a whole number of updates within each output interval. | | |
| **INS Model message interval** | Not applicable for SimINERTIAL<br>When the message rate and the rate set in menu item **Options-*General Options* - Simulation iteration rate** (page 5-15) not coincide, SimGEN assigns INS data at the required times, but the messages may be buffered for batch output at the hardware update interval. | | |
| | Units: milliseconds | Range: 1 to 10 000 ms | Default: 10 |
| **Output reference frame** | Not applicable for SimINERTIAL<br>Choose whether the output from the model uses **body** or **local** reference frames. | | |
| **Gravity model selection** | Choose from these models:<br>**WGS84 formula (Somigliana)** (default) **Simple gravity** (enables **Gravity pull**) **WGS84 model (up to 180x180)**<br>**WGS84/EGM96 (up to 360x360)**, **GEM T3**<br>The model you select enables **Gravity model degree**, **Gravity model order** and **Gravity pull**, as appropriate. | | |
| **Gravity model degree**<br>**Gravity model order** | Defines the degree and order of the following gravity models<br>***Note**: The order cannot exceed the degree.* | | |
| **WGS 84** | degree: 1 to 180<br>order: 1 to 180 | Default: degree: 1, order: 1 | |
| **WGS 84/EGM96** | degree: 1 to 360<br>order: 1 to 360 | Default: degree: 1, order : 1 | |
| **GEM T3** | degree: 1 to 8<br>order: 1 to 8 | Default: degree: 1, order : 1 | |
| **Gravity pull** | (Enabled by **Gravity model selection**-**Simple gravity)**<br>Type the value of gravity a body experiences at the Earth's ellipsoidal surface with respect to all latitudes and longitudes. Before converting to the final value of gravity, SimGEN applies an inverse-square law to compensate for height above the Earth's ellipsoidal surface. | | |
| | Units: metres per (second)$^2$ | Range: 0 to 20 m.s$^{-2}$ | Default: 9.78 |
| **Gravity to remain constant** | Deselect (default): runs the **Gravity model** continuously during the scenario.<br>Select: runs the **Gravity model** once at the beginning of the scenario and uses the calculated value of gravity, which is constant for all latitudes, longitudes and heights of the scenario, throughout the scenario. | | |
| **Gravity output switch** | Not applicable for SimINERTIAL<br>Deselect (default): does not include gravitational effects in the output acceleration data.<br>Select: includes gravitational effects in the output acceleration data. | | |
| **Gravity anomaly vector** | Not applicable for SimINERTIAL<br>Defines offset in the gravity vector in terms of Xi and Eta | | |
| **Deviation of the vertical about East (Xi)** and **Deviation of the vertical about North (Eta)** | Units: radians | Range: ± 0.1 rad | Default: 0 |

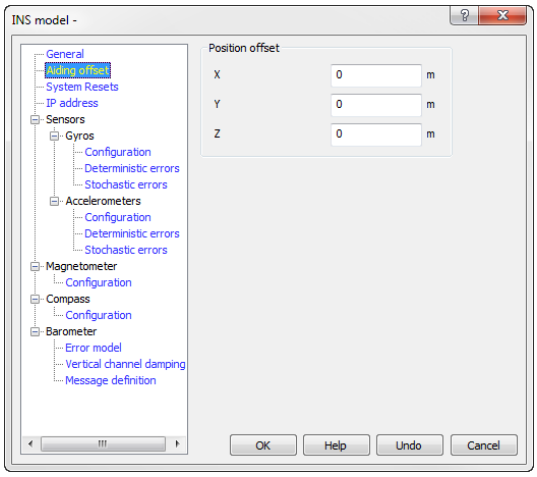


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| | | | |
|---|---|---|---|
| **Deviation in vertical gravity component-** | Units: metres per (second)$^2$ | Range: ± 1 m.s$^{-2}$ | Default: 0 |
| **IMU motion data offset** | Sets the timing offset of output messages for SimINERTIAL (ΔVs,Δθs) with respect to the simulation time | | |
| | Units: microseconds | Range:<br>± 100 000 µs<br>(but limited to the current **Simulation iteration rate**) | Default: 0 |
| **Truth Aiding-Linear Inertial Motion (body axis + local geodetic)** | Deselect (default): does not send messages to the UDP data stream<br>Select: sends a body axis message and an earth axis message to the UDP data stream - see reference qq). | | |

## 22.2 Aiding offset

You can use data from other navigation sensors to aid the GPS receiver. To do so, you must enter the offset of the GPS receiver antenna from the navigation sensor using the **Aiding Offsets** dialog:



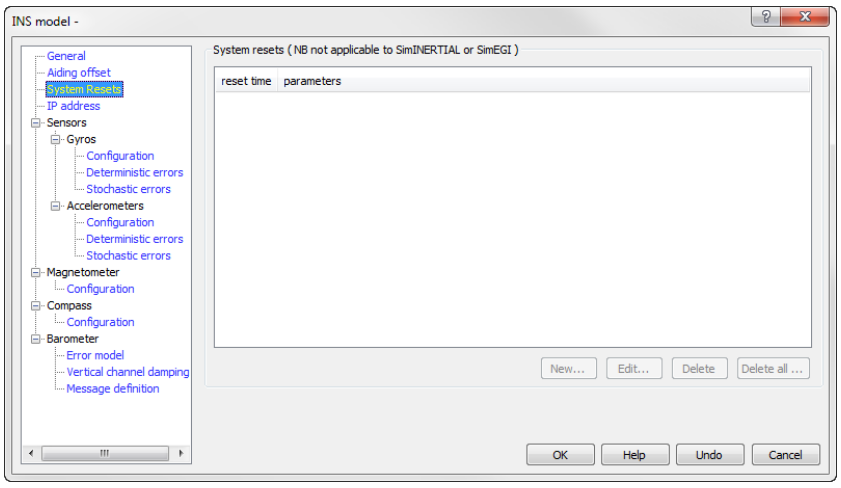

This data creates the aiding offset file with the default filename *default_vx-yy.aid*.

| | | | |
|---|---|---|---|
| **X, Y, Z** | Units: metres | Range: ±500 m | Default: 0 |

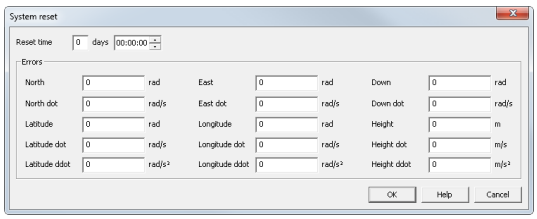
## 22.3 System resets

***Note**: **System resets** are only applicable to local INS models. They are not applicable to SimINERTIAL.*

Click on **INS model-System resets** to see the **System reset** dialog:




Click **New** to open the **System reset** dialog:




This dialog assigns the reset time and the errors applied to the INS model parameters. If there are no system resets defined or there is no set defined at **Reset time** of zero, then all errors default to zero at the start of the run.

You can make an unlimited number of reset commands.

You can reset the **Errors** at the time (d hh:mm:ss) you enter in **Reset time**. This table gives the characteristics of each error you can set.

| Error type | Error | Range | Unit |
|---|---|---|---|
| **Attitude** | **North, East, Down** | -0.1 to 0.1 | rad |
| **Attitude rate** | **North dot, East dot, Down dot** | -0.001 to 0.001 | $rad.s^{-1}$ |
| **Position** | **Latitude, Longitude** | -0.001 to 0.001 | rad |
| | **Height** | -100 to 100 | m |
| **Velocity** | **Latitude dot, Longitude dot** | -1E-06 to 1E-06 | $rad.s^{-1}$ |
| | **Height dot** | -1 to 1 | $m.s^{-1}$ |
| **Acceleration** | **Latitude ddot, Longitude ddot** | -1E-09 to 1E-09 | $rad.s^{-2}$ |
| | **Height ddot** | -0.1 to 0.1 | $m.s^{-2}$ |

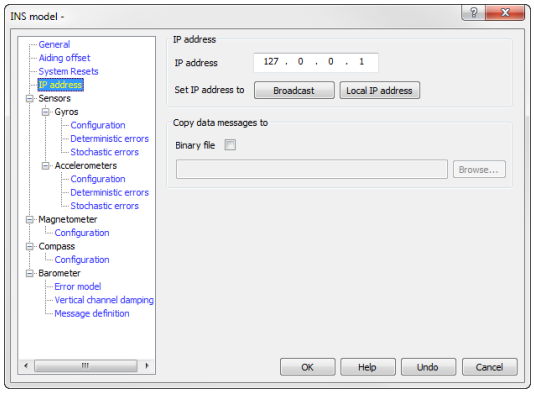
## 22.4 IP address

***Notes*** *When running in Turbo mode (see* ***Scenario toolbar - left-hand side*** *(page 6-1)):*

***1)*** *You can only send status data over UDP.*

***2)*** *Binary file data for the scenario is available. You can copy it to a *.bin file.*

This dialog, lets you enter the destination of the data streamed (UDP) messages. It applies for local (INS system output messages) and remote applications (for aiding motion data). The figure below shows the **IP address** dialog when using a C50r SimGEN Host:




| | |
|---|---|
| **IP address** | Sets the IP address for UDP messages<br>Click to set the default IP address as follows:<br>**Broadcast** : 255.255.255.255<br>**Loopback**: 127.0.0.1<br>This button is also visible when using a C50r SimGEN Host:<br>**Windows VM** 192.168.25.1 |


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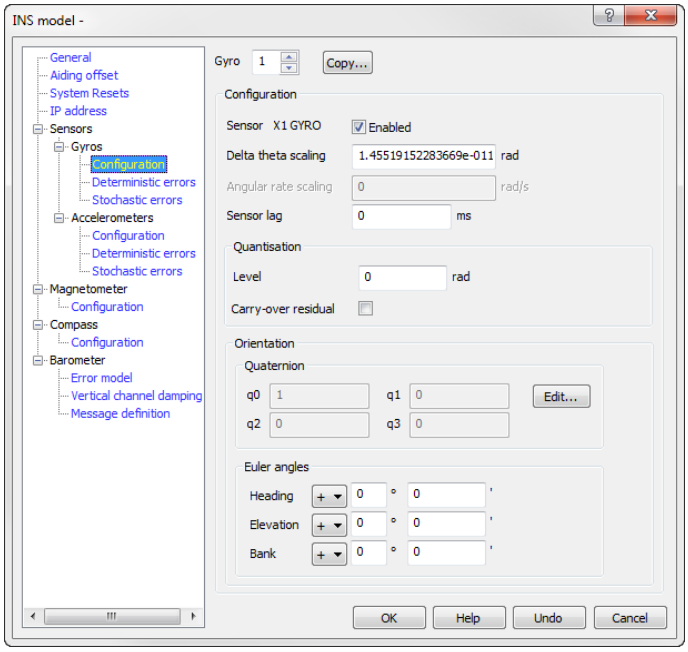
| | |
|---|---|
| **Binary file** | Deselect (default): does not copy data messages to a binary file<br>Select: copies data messages to a file. Click **Browse** and navigate to the location where you want to store this binary file (**.bin*) |

## 22.5 Sensors - Gyros

The following sections detail the gyro settings.

### 22.5.1 Configuration

Use this dialog to define configuration data for up to six gyros for the INS system.



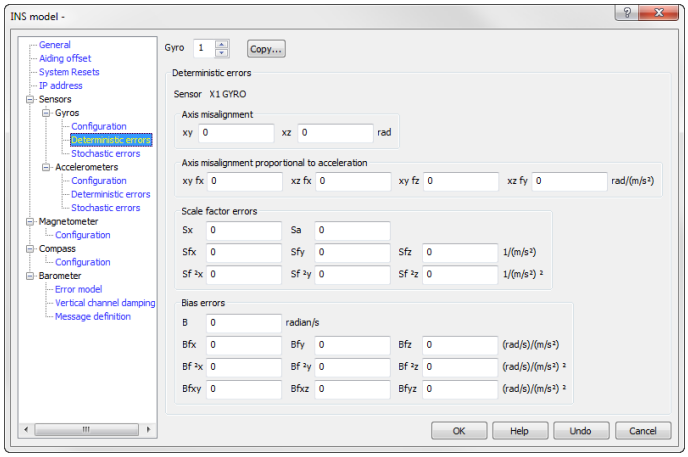

| | | | |
|---|---|---|---|
| **Gyro** | Select the Gyro you want to configure. The six gyros are designated as a **Sensor**:<br>**Gyro 1**: Sensor X1 GYRO<br>**Gyro 2**: Sensor Y1 GYRO<br>**Gyro 3**: Sensor Z1 GYRO<br>**Gyro 4**: Sensor X2 GYRO<br>**Gyro 5**: Sensor Y2 GYRO<br>**Gyro 6**: Sensor Z2 GYRO<br><br>These names represent the nominal direction of the sensitive axes of the gyros with respect to the IMU axes (X,Y,Z). Spirent assumes they coincide with the vehicle axes so the input axis of X1 GYRO is nominally along the designated x-axis of the vehicle.<br><br>Click Copy to copy this configuration to the Gyros you select in the Copy dialog. | | |
| **Sensor** <sensor name> **Enabled** | Deselect: disables the **Gyro (Gyros X2, Y2 Z2** are disabled by default)<br>Select: enables the **Gyro (Gyros X1, Y1 Z1** are enabled by default) | | |
| **Delta theta scaling** | Determines the value of the least-significant bit of the scaled sensor output for $\Delta\theta$<br>SimINERTIAL uses this data<br>Spirent supplies appropriate default scaling values for the Litton LN-100G system | | |
| | Units: radian | Range: ± 0.1 rad | Default: 0 |
| **Angular rate scaling** | ***Note**: This scaling does not apply for the Honeywell H764G IRS system (values are floating-point), or for local INS models* | | |
| | Units: radian per second | Range<br>± 0.1 rad.s$^{-1}$ | Default: 0 |


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| | | | |
|---|---|---|---|
| **Sensor lag** | Defines the lag ($\tau$) applied to the sensor output using:<br>$x(t) = (1-k).x(t - \Delta t) + k.u(t)$<br><br>Where:<br>$k = 1 - \exp(-\Delta t/\tau)$ (Defaults to 1 when $\tau = 0$ )<br>$u(t)$ = input to sensor at time t<br>$\Delta t$ = sampling interval you type in **Sensor lag** | | |
| | Units: milliseconds | Range: 0 to 1 000 ms | Default: 0 |
| **Orientation** | You can precisely define the orientation of the reference frame for each sensor with respect to the IMU axes (or platform frame).<br>Spirent denotes the sensor axes as $X_s$, $Y_s$, $Z_s$, so defining $X_s$ as the sensitive (input) axis of the sensor.<br>You can enter the attitude of the sensor as a **Quaternion** set (**q0**, **q1**, **q2**, **q3**), or as a series of **Euler angle** rotations in the sequence **heading**, **elevation** and **bank**.<br>SimGEN automatically determines and displays the alternative orientation from the data you enter.<br><br>With coincident sensor and IMU (or body) frames, the Quaternion representation is (1,0,0,0) and all Euler angles are zero.<br>The magnitude of the Quaternion must always be unity and this is automatically normalised after you have finished entering data.<br>The default selection of attitude aligns the input axis for sensors Gyro1, Gyro2 and Gyro3 along the X-, Y- and Z- axes, respectively, of the IMU. This repeats for sensors 4 to 6.<br>You can modify the sensor attitude to apply known, small offsets in alignment; or to change this completely in a system where there is significant offset in the sensor input axes from the IMU frame.<br><br>***Note**: The default settings also imply specific directions for the Ys- and Zs- axes.*<br>*These may not correspond with the true orientation of the sensor, even though the direction of the sensitive axis may be correct.*<br>*Amend the attitude accordingly where acceleration-dependent error changes significantly for the different axes.* | | |
| **Quaternion** | Click **Edit** to change the defaults for Quaternion **q0** to **q3** | | |
| | Units: none | Range: ± 1.0 | Default: (1,0,0,0) for (q0,q1,q2,q3) |
| **Euler angles** | | | |
| **Heading**<br>**Elevation**<br>**Bank** | Units: degrees | Range:<br>Heading: ± 180.0°<br>Elevation: ± 90.0°<br>Bank: ± 180.0° | Default:<br>Heading: 0<br>Elevation: 0<br>Bank: 0 |

## 22.5.2 Deterministic errors

This dialog introduces deterministic (that is, non-random) errors for each sensor.





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For each gyro, you can define the following:

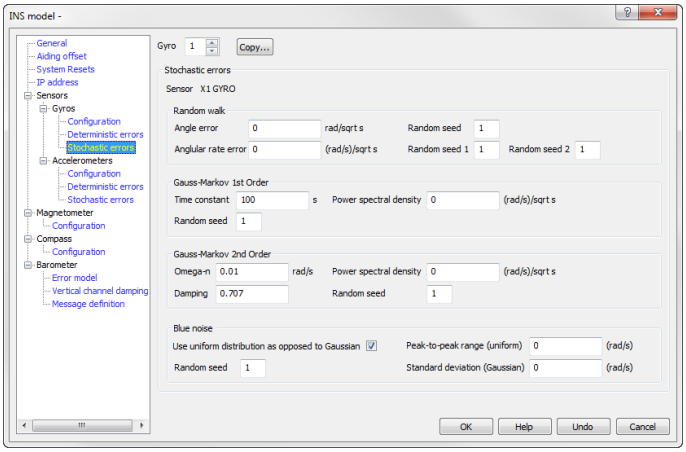
| | | | |
|---|---|---|---|
| **Gyro** | Select the Gyro you want to configure. The six gyros are designated:<br>**Gyro 1**: Sensor X1 GYRO<br>**Gyro 2**: Sensor Y1 GYRO<br>**Gyro 3**: Sensor Z1 GYRO<br>**Gyro 4**: Sensor X2 GYRO<br>**Gyro 5**: Sensor Y2 GYRO<br>**Gyro 6**: Sensor Z2 GYRO<br><br>Click Copy to copy this configuration to the Gyros you select in the Copy dialog. | | |
| **Axis misalignment** | Misalignment of "true" sensor axis ($X_s$) in terms of rotation about the nominal sensor $Y_s$- and $Z_s$- axes | | |
| **xy** and **xz** | Units: radians | Range: ± 0.02 rad | Default: 0 |
| **Axis misalignment proportional to acceleration** | Perturbation of the axis misalignment (as a function of acceleration along the $X_s$-axis) of the "true" sensor axis $X_s$, It gives rotation about both $Y_s$- and $Z_s$-axes.<br>Acceleration along $Y_s$-axis gives rotation about $Z_s$-axis.<br>Acceleration along $Z_s$-axis gives rotation about $Y_s$-axis. | | |
| **xy fx** and **xz fx,**<br>**xz fy** and **xy fz** | Units: radians per (metre per (second)$^2$) | Range: ± 0.000 1 rad.(m.s$^{-2}$)$^{-1}$ | Default: 0 |
| **Scale factor errors** ***Note****: **Sx** and **Sa** are cumulative.* | | | |
| **Sx** | Fixed error-component<br>$S_x.s_i$, gives the measurement error, where $s_i$ is the "true" sensor input. | | |
| | Units: none | Range: ± 0.1 | Default: 0 |
| **Sa** | Asymmetry error<br>Fixed scale factor error, independent of the measurement sign.<br>Sa.\|si\| gives the error, which is unaffected by applied acceleration. | | |
| | Units: none | Range: ± 0.1 | Default: 0 |
| **Sfx**, **Sfy** and **Sfz** | Proportional to acceleration<br>Perturbation of scale factor error as a function of acceleration along all three sensor axes. | | |
| | Units: 1/(metre per (second)$^2$) | Range: ± 0.1 (m.s$^{-2}$)$^{-1}$ | Default: 0 |
| **Sf$^2$x, Sf$^2$y** and **Sf$^2$z** | Proportional to square of acceleration<br>Perturbation of scale factor error as a function of the square of acceleration along all three sensor axes. | | |
| | Units: 1/(metre per (second)$^2$)$^2$ | Range: ± 0.1 (m.s$^{-2}$)$^{-2}$ | Default: 0 |
| **Bias errors** | | | |
| **B** | Fixed bias - the fixed error component for the gyro angular rate | | |
| | Units: radians per second | Range: ± 0.2 rad.s$^{-1}$ | Default: 0 |
| **Bfx**, **Bfy**, **Bfz** | Proportional to acceleration<br>Error components are a function of acceleration along each sensor axis. | | |
| | Units: (radians per second) per (metre per (second)$^2$) | Range:<br>± 0.2 (rad.s$^{-1}$). (m.s$^{-2}$)$^{-1}$ | Default: 0 |
| **Bf$^2$x Bf$^2$y, Bf$^2$z** | Proportional to square of acceleration<br>Error components are a function of the square of acceleration along each sensor axis. | | |
| | Units: (radians per second) per (metre per (second)$^2$)$^2$ | Range:<br>± 0.02 (rad.s$^{-1}$). (m.s$^{-2}$)$^{-2}$ | Default: 0 |


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| | | | |
|---|---|---|---|
| **Bfxy, Bfxz, Bfyz** | Proportional to the product of acceleration<br>Error components are a function of the square of the product of acceleration for orthogonal sensor axes (anisoelasticity). | | |
| | Units: (radians per second) per (metre per (second)$^2$)$^2$ | Range:<br>± 0.02 (rad.s$^{-1}$). (m.s$^{-2}$)$^{-2}$ | Default: 0 |

## 22.5.3 Stochastic errors

Use the dialog to enable independent, random error effects for each sensor.




Each random process has an associated (user-defined) value for **Random seed**, which together with the sensor type and id, initialises the random number generator for this process. Using the same seed number for different sensors gives a different random sequence. You can specify values for **Random seed** in the range 0 to 9 999. Selecting a value of zero randomly determines the **Random seed** in this range, hence changing the run-to-run behaviour.

A non-zero value for **Random seed** applies the same random sequence for each run.

You can define parameters for the following stochastic effects:

| | | | |
|---|---|---|---|
| **Random walk** | "White noise" in sensor data - a random walk effect for the integrated velocity and angle values in the INS solution. Section 3.2.4.1 of reference n) details how to determine the random offset in measured delta values, using:<br><br>Angle/Velocity random walk error = $\sqrt{}$( q.$\Delta$t).N(0,1)<br><br>Where:<br>q = Power spectral density of applied white noise<br>$\Delta$t = Sampling (integration) interval<br>N(0,1) = Random value from Gaussian distribution with mean of zero and standard deviation of 1.<br>Assigns a seed value for process initialisation. | | |
| **Random walk bias** | A random walk in the sensor bias error, section 3.2.4.3 of reference n) details how to determine this.<br>Spirent derives the following equations from this reference:<br><br>Sensor bias error at t + $\Delta$t = $x_2$(t) + 0.5$\sqrt{}$(q.$\Delta$t)($N_1/\sqrt{3} + N_2$)<br><br>Where:<br>$x_2(t) = x_2(t - \Delta t) + \sqrt{}q.\Delta t.N_2$<br>$\Delta$t = sampling interval<br>q = Power spectral density of applied white noise<br>$N_1 = N_1(0,1)$<br>$N_2 = N_2(0,1)$<br>Assigns two seed values for initialisation of the random processes. | | |
| **Angle error** | Units: radians per (second)$^{1/2}$ | Range: 0 to 0.1 rad.(s$^{-1/2}$) | Default: 0 |



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| | | | |
|---|---|---|---|
| **Angular rate error** | Units: (radians per second) per (second)$^{1/2}$ | Range: 0 to 0.1 (rad.s$^{-1}$).(s$^{-1/2}$) | Default: 0 |
| **Random seed** | Units: none | Range: 0 to 9 999 | Default: 1 |
| **Random seed 1** | Units: none | Range: 0 to 9 999 | Default: 1 |
| **Random seed 2** | Units: none | Range: 0 to 9 999 | Default: 1 |
| **Gauss-Markov 1st Order** | Section 3.2.4.5 of reference n) defines the first-order Gauss-Markov process. This gives a randomly varying offset in the sensor output (angular rate or acceleration). | | |
| **Time constant** | Units: seconds | Range: 1.0 E-6 to 9 999 s | Default: 100 |
| **Random seed** | Units: none | Range: 0 to 9 999 | Default: 1 |
| **Power spectral density** | Units: (radians per second) per (second)$^{1/2}$ | Range: 0 to 0.1 (rad.s$^{-1}$).(s$^{-1/2}$) | Default: 0 |
| **Gauss-Markov 2nd Order** | Section 3.2.4.6 of reference n) defines the second-order Gauss-Markov process. This gives a randomly varying offset in the sensor output (angular rate or acceleration) | | |
| **Omega-n** | Units: radians per second | Range: 1.0 E-6 to 9 999 rad.s$^{-1}$ | Default: 0.01 |
| **Damping** | Units: none | Range: 0.000 1 to 0.999 9 | Default: 0.707 |
| **Power spectral density** | Units: (radians per second) per (second)$^{1/2}$ | Range: 0 to 0.1 (rad.s$^{-1}$).(s$^{-1/2}$) | Default: 0 |
| **Random seed** | Units: none | Range: 0 to 9 999 | Default: 1 |
| **Blue noise** | The power density of blue noise is proportional to frequency (over a finite frequency range) Blue noise offers a good noise model for dithering, for example MEMS sensors exhibit blue noise. | | |
| **Use uniform distribution as opposed to Gaussian** | Select (default): enables using uniform distribution as opposed to Gaussian<br>Deselect: use Gaussian distribution | | |
| **Peak-to-peak range (uniform)** | Units: radians per second | Range: 0 to 0.1 rad.s$^{-1}$ | Default: 0 |
| **Random seed** | Units: none | Range: 0 to 9 999 | Default: 1 |
| **Standard deviation (Gaussian)** | Units: radians per second | Range: 0 to 0.1 rad.s$^{-1}$ | Default: 0 |

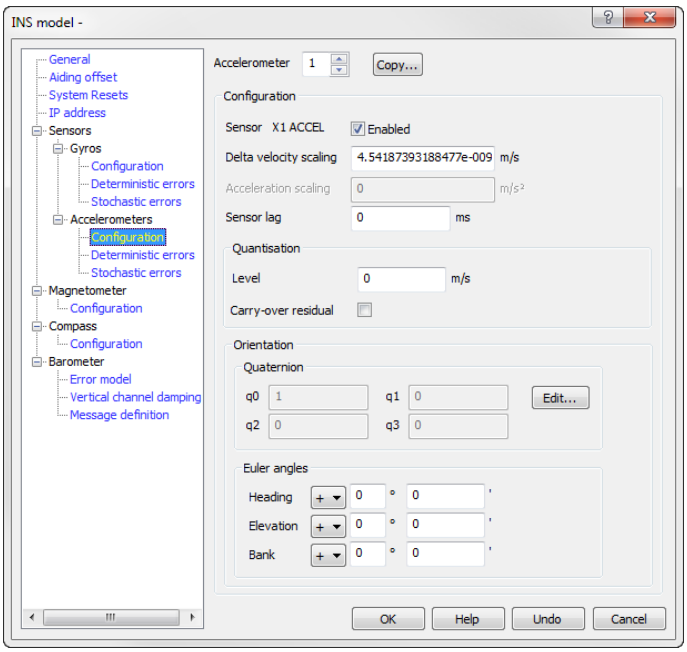
## 22.6 Sensors - Accelerometers

The following sections describe the settings for accelerometers

### 22.6.1 Configuration

Use this dialog to define the configuration data for up to six accelerometers for the INS system.


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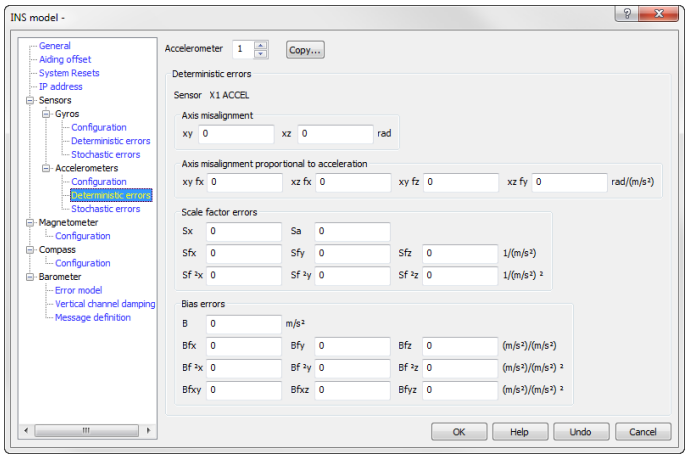

| | |
|---|---|
| **Accelerometer** | Select the Accelerometer you want to configure. The six accelerometers are designated as a **Sensor**:<br>**Accelerometer 1**: Sensor X1 ACCEL<br>**Accelerometer 2**: Sensor Y1 ACCEL<br>**Accelerometer 3**: Sensor Z1 ACCEL<br>**Accelerometer 4**: Sensor X2 ACCEL<br>**Accelerometer 5**: Sensor Y2 ACCEL<br>**Accelerometer 6**: Sensor Z2 ACCEL<br><br>These names represent the nominal direction of the sensitive axes of the gyros with respect to the IMU axes (X,Y,Z). Spirent assumes they coincide with the vehicle axes so the input axis of X1 ACCEL is nominally along the designated x-axis of the vehicle.<br><br>Click Copy to copy this configuration to the Accelerometers you select in the Copy dialog. |
| **Enabled** | Deselect: disables the **Accelerometer (Accelerometers X2, Y2 Z2** are disabled by default)<br>Select: enables the **Accelerometer (Accelerometers X1, Y1 Z1** are enabled by default) |
| **Delta velocity scaling** | Determines the value of the least-significant bit of the scaled sensor output for $\Delta V$. SimINERTIAL uses this data<br>Spirent supplies appropriate default scaling values for the Litton LN-100G system. |
| | Units: metres per second / Range: $\pm$ 0.1 $m.s^{-1}$ / Default: 0 |
| **Acceleration scaling** | |
| | Units: metres per $(second)^2$ / Range: $\pm$ 0.1 $rad.s^{-1}$ / Default: 0 |
| ***Note**: This scaling does not apply for the Honeywell H764G IRS system (values are floating-point), or for local INS models* | |
| **Sensor lag** | Defines the lag ($\tau$) applied to the sensor output using:<br>$x(t) = (1-k).x(t - \Delta t) + k.u(t)$<br><br>Where:<br>$k = 1 - \exp(-\Delta t/\tau)$ (Defaults to 1 when $\tau = 0$ )<br>$u(t)$ = input to sensor at time t<br>$\Delta t$ = sampling interval you type in **Sensor lag** |


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| | | | |
|---|---|---|---|
| | Units: milliseconds | Range: 0<br>to 1 000 ms | Default: 0 |
| **Orientation** | You can precisely define the orientation of the reference frame for each sensor with respect to the IMU axes (or platform frame).<br>Spirent denotes the sensor axes as $X_s$, $Y_s$, $Z_s$, so defining $X_s$ as the sensitive (input) axis of the sensor.<br>You can enter the attitude of the sensor as a **Quaternion** set (**q0**, **q1**, **q2**, **q3**); or as a series of **Euler angle** rotations in the sequence **heading**, **elevation** and **bank**.<br>SimGEN automatically determines and displays the alternative orientation from the data you enter.<br>With coincident sensor and IMU (or body) frames, the Quaternion representation is (1,0,0,0) and all Euler angles are zero.<br>The magnitude of the Quaternion must always be unity and this is automatically normalised after you have finished entering data.<br>The default selection of attitude aligns the input axis for sensors Accel1, Accel2 and Accel3 along the X-, Y- and Z- axes, respectively, of the IMU. This repeats for sensors 4 to 6.<br>You can modify the sensor attitude to apply known, small offsets in alignment; or to change this completely in a system where there is significant offset in the sensor input axes from the IMU frame. | | |
| ***Note**: The default settings also imply specific directions for the Y- and Z- axes.*<br>*These may not correspond with the true orientation of the sensor, even though the direction of the sensitive axis may be correct.*<br>*Amend the attitude accordingly where acceleration-dependent error changes significantly for the different axes.* | | | |
| **Quaternion** | Click **Edit** to change the defaults for Quaternion **q0** to **q3** | | |
| | Units: none | Range: ± 1.0 | Default: (1,0,0,0)<br>for (q0,q1,q2,q3) |
| **Euler angles** | | | |
| | Units: degrees | Range:<br>Heading: ± 180.0°<br>Elevation: ± 90.0°<br>Bank: ± 180.0 | Default:<br>Heading: 0, Elevation: 0,<br>Bank: 0 |

## 22.6.2 Deterministic errors

Use this dialog to enter deterministic (non-random) error effects for each sensor.




For each accelerometer, you can define the following:

| | | | |
|---|---|---|---|
| **Accelerometer** | Select the Accelerometer you want to configure. The six accelerometers are designated as a **Sensor**:<br>**Accelerometer 1**: Sensor X1 ACCEL<br>**Accelerometer 2**: Sensor Y1 ACCEL<br>**Accelerometer 3**: Sensor Z1 ACCEL<br>**Accelerometer 4**: Sensor X2 ACCEL<br>**Accelerometer 5**: Sensor Y2 ACCEL<br>**Accelerometer 6**: Sensor Z2 ACCEL<br><br>These names represent the nominal direction of the sensitive axes of the gyros with respect to the IMU axes (X,Y,Z). Spirent assumes they coincide with the vehicle axes so the input axis of X1 ACCEL is nominally along the designated x-axis of the vehicle.<br><br>Click Copy to copy this configuration to the Accelerometers you select in the Copy dialog. | | |
| **Axis misalignment** | Misalignment of “true” sensor axis ($X_s$) in terms of rotation about the nominal sensor $Y_s$- and $Z_s$- axes | | |
| **xy** and **xz** | Units: radians | Range: ± 0.02 rad | Default: 0 |
| **Axis misalignment proportional to acceleration** | Perturbation of the axis misalignment (as a function of acceleration along the $X_s$-axis ) of the “true” sensor axis $X_s$,<br>It gives rotation about both $Y_s$- and $Z_s$-axes.<br>Acceleration along $Y_s$-axis gives rotation about $Z_s$-axis.<br>Acceleration along $Z_s$-axis gives rotation about $Y_s$-axis. | | |
| **xy fx** and **xz fx,**<br>**xz fy** and **xy fz** | Units: radians per (metre per (second)$^2$) | Range:<br>± 0.000 1 rad.$(m.s^{-2})^{-1}$ | Default: 0 |
| **Scale factor errors** | ***Note**: **Sx** and **Sa** are cumulative.* | | |
| **Sx** | Fixed error-component<br>$S_x.s_i$, gives the measurement error, where $s_i$ is the “true” sensor input. | | |
| | Units: none | Range: ± 0.1 | Default: 0 |
| **Sa** | Asymmetry error<br>Fixed scale factor error, independent of the measurement sign.<br>Sa.\|si\| gives the error, which is unaffected by applied acceleration. | | |
| | Units: none | Range: ± 0.1 | Default: 0 |
| **Sfx**, **Sfy** and **Sfz** | Proportional to acceleration<br>Perturbation of scale factor error as a function of acceleration along all three sensor axes. | | |
| | Units: 1/(metre per(second)$^2$) | Range: ± 0.1 $(m.s^{-2})^{-1}$ | Default: 0 |
| **Sf$^2$x, Sf$^2$y** and **Sf$^2$z** | Proportional to square of acceleration<br>Perturbation of scale factor error as a function of the square of acceleration along all three sensor axes. | | |
| | Units: 1/(metre per (second)$^2$)$^2$ | Range: ± 0.1 $(m.s^{-2})^{-2}$ | Default: 0 |
| **Bias errors** | | | |
| **B** | Fixed bias - the fixed error component for the acceleration | | |
| | Units: metre per (second)$^2$ | Range: ± 100 $m.s^{-2}$ | Default: 0 |
| **Bfx**, **Bfy**, **Bfz** | Proportional to acceleration<br>Error components are a function of acceleration along each sensor axis. | | |
| | Units:(metres per (second)$^2$) per (metre per (second)$^2$) | Range:<br>± 10 $(m.s^{-2}).(m.s^{-2})^{-1}$ | Default: 0 |

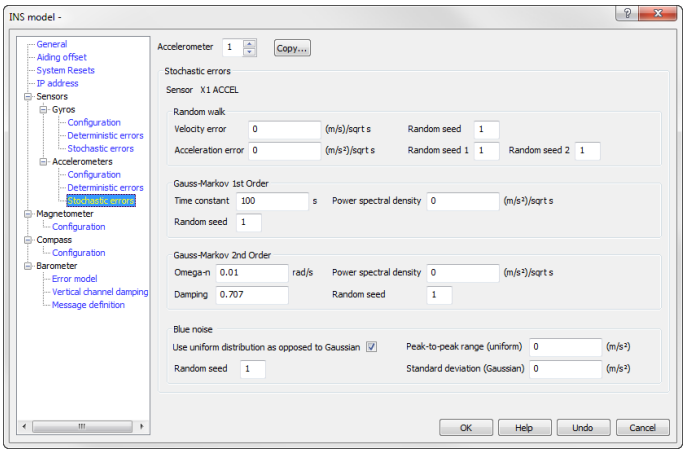


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| | | | |
|---|---|---|---|
| **$Bf^2x$ $Bf^2y$, $Bf^2z$** | Proportional to square of acceleration<br>Error components are a function of the square of acceleration along each sensor axis. | | |
| | Units:(metres per (second)$^2$ per (metre per (second)$^2$)$^2$ | Range:<br>± 10 (m.s$^{-2}$).(m.s$^{-2}$)$^{-2}$ | Default: 0 |
| **Bfxy, Bfxz, Bfyz** | Proportional to the product of acceleration<br>Error components are a function of the square of the product of acceleration for orthogonal sensor axes (anisoelasticity). | | |
| | Units: (metres per (second)$^2$ per (metre per (second)$^2$)$^2$ | Range:<br>± 10 (m.s$^{-2}$).(m.s$^{-2}$)$^{-2}$ | Default: 0 |

## 22.6.3 Stochastic errors

Use the dialog to enable independent, random error effects for each sensor.




Each random process has an associated (user-defined) value for **Random seed**, which together with the sensor type and id, initialises the random number generator for this process. Using the same seed number for different sensors gives a different random sequence. You can specify values for **Random seed** in the range 0 to 9 999. Selecting a value of zero randomly determines the **Random seed** in this range, hence changing the run-to-run behaviour.

A non-zero value for **Random seed** applies the same random sequence for each run.

You can define parameters for the following stochastic effects:

| | |
|---|---|
| **Random walk** | "White noise" in sensor data - a random walk effect for the integrated velocity and angle values in the INS solution. Section 3.2.4.1 of reference n) details how to determine the random offset in measured delta values, using:<br>Angle/Velocity random walk error = $\sqrt{}$( q.$\Delta$t).N(0,1)<br>Where:<br>q = Power spectral density of applied white noise<br>$\Delta$t = Sampling (integration) interval<br>N(0,1) = Random value from Gaussian distribution with mean of zero and standard deviation of 1.<br>Assigns a seed value for process initialisation. |


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| | | | |
|---|---|---|---|
| **Random walk bias** | A random walk in the sensor bias error. Section 3.2.4.3 of reference n) details how to determine this.<br>Spirent derives the following equations from this reference:<br>Sensor bias error at $t + \Delta t = x_2(t) + 0.5\sqrt{(q.\Delta t)}(N_1/\sqrt{3} + N_2)$<br>Where:<br>$x_2(t) = x_2(t - \Delta t) + \sqrt{q}.\Delta t.N_2$<br>$\Delta t$ = sampling interval<br>q = Power spectral density of applied white noise<br>$N_1 = N_1(0,1)$<br>$N_2 = N_2(0,1)$<br>Assigns two seed values for initialisation of the random processes. | | |
| **Velocity error** | Units: (metres per second) per $(\text{second})^{1/2}$ | Range: 0 to 10 $m.s^{-1}.(s^{-1/2})$ | Default: 0 |
| **Acceleration error** | Units: (metres per $(\text{second})^2$) per $(\text{second})^{1/2}$ | Range: 0 to 10 $m.s^{-2}.s^{-1/2}$ | Default: 0 |
| **Random seed** | Units: none | Range: 0 to 9 999 | Default: 1 |
| **Random seed 1** | Units: none | Range: 0 to 9 999 | Default: 1 |
| **Random seed 2** | Units: none | Range: 0 to 9 999 | Default: 1 |
| **Gauss-Markov 1st Order** | Section 3.2.4.5 of reference n) defines the first-order Gauss-Markov process. This gives a randomly varying offset in the sensor output (angular rate or acceleration). | | |
| **Time constant** | Units: seconds | Range: 1.0 E-6 to 9 999 s | Default: 100 |
| **Random seed** | Units: none | Range: 0 to 9 999 | Default: 1 |
| **Power spectral density** | Units: $(\text{metres per (second)}^2)$ per $(\text{second})^{1/2}$ | Range: 0 to 10 $m.s^{-2}.s^{-1/2}$ | Default: 0 |
| **Gauss-Markov 2nd Order** | Section 3.2.4.6 of reference n) defines the second-order Gauss-Markov process. This gives a randomly varying offset in the sensor output (angular rate or acceleration). | | |
| **Omega-n** | Units: radians per second | Range: 1.0 E-6 to 9 999 $rad.s^{-1}$ | Default: 0.01 |
| **Damping** | Units: none | Range: 0.000 1 to 0.999 9 | Default: 0.707 |
| **Power spectral density** | Units: $(\text{metres per (second)}^2)$ per $(\text{second})^{1/2}$ | Range: 0 to 10 $m.s^{-2}.s^{-1/2}$ | Default: 0 |
| **Random seed** | Units: none | Range: 0 to 9 999 | Default: 1 |
| **Blue noise** | The power density of blue noise is proportional to frequency (over a finite frequency range) Blue noise offers a good noise model for dithering, for example MEMS sensors exhibit blue noise. | | |
| **Use uniform distribution as opposed to Gaussian** | Select (default): enables using uniform distribution as opposed to Gaussian<br>Deselect: use Gaussian distribution | | |
| **Peak-to-peak range (uniform)** | Units: radians per second | Range: 0 to 0.1 $rad.s^{-1}$ | Default: 0 |
| **Random seed** | Units: none | Range: 0 to 9 999 | Default: 1 |
| **Standard deviation (Gaussian)** | Units: radians per second | Range: 0 to 0.1 $rad.s^{-1}$ | Default: 0 |

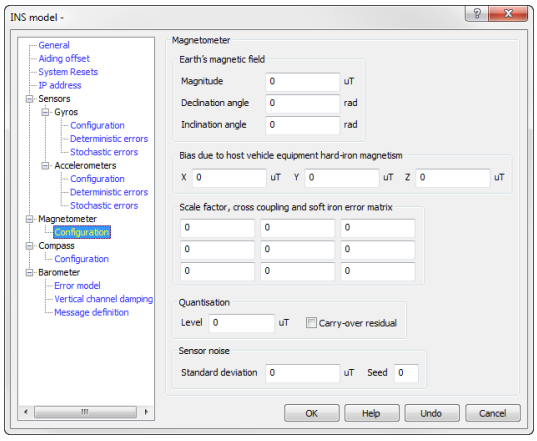


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# 22.7 Magnetometer

Use this dialog to enter details for a three-axis magnetometer measuring magnetic flux density along three mutually-perpendicular axes.

## 22.7.1 Configuration




| | | | |
|---|---|---|---|
| **Earth's magnetic field** | Enter values of the Earth's magnetic field at the location of the magnetometer sensor | | |
| **Magnitude** | Units: microTesla | Range: 0 to 100 µT | Default: 0 |
| **Declination angle (or magnetic variation)** | Units: radian | Range: ±π rad | Default: 0 |
| **Inclination angle (or dip angle)** | Units: radian | Range: ±π/2 rad | Default: 0 |
| **Bias due to host vehicle equipment hard-iron magnetism** | Enter values of magnetic field within the vehicle at the location of the magnetometer sensor | | |
| **X, Y, Z** | Units: microTesla | Range: ±10 µT | Default: 0 |
| **Scale factor, cross coupling and soft iron error matrix** | A unit-less matrix representing host vehicle equipment soft-iron magnetism and sensor errors.<br>Uses body-frame axes with columns corresponding to the (x, y, z) axes of the true magnetic flux density and rows corresponding to the axes of the (x, y, z) sensor errors. | | |
| | Main diagonal | Range: ±1.25 | Default: 0 |
| | Other elements | Range: ±0.25 | Default: 0 |
| **Quantisation** | Quantization errors occur when the sensor output is converted into an integer multiple of a constant (quantization level), for example after analog-to-digital conversion of a signal. | | |
| **Level** | Units: microTesla | Range: 0 to 1 µT | Default: 0 |
| **Carry-over residual** | The difference between the un-quantised magnetometer output vector and the quantised one.<br>Deselect (default): does not add the residual into the next epoch<br>Select: adds the residual into the next epoch | | |
| **Sensor noise** | The random noise of the magnetometer triad, obtained by selecting three random numbers from a zero-mean Gaussian distribution, whose standard deviation you define. | | |
| **Standard deviation** | Units: microTesla | Range: 0 to 24 µT | Default: 0 |


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| | | | |
|---|---|---|---|
| **Seed** | Units: none | Range: 0 to 100 | Default: 0 |

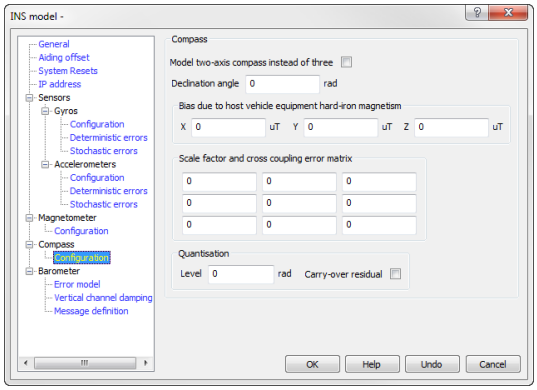
## 22.8 Compass

Use this dialog to enter details for a three- or two-axis compass.

The three-axis compass determines magnetic and true heading from the magnetic flux density and specific force along three mutually-perpendicular axes. This model assumes the instruments are stationary (or moving at constant velocity).

The two-axis compass determines magnetic and true heading from two perpendicular magnetic flux density measurements in the horizontal plane. The magnetic compass must be kept horizontal and has no restrictions on acceleration.

### 22.8.1 Configuration




| | | | |
|---|---|---|---|
| **Model two-axis compass instead of three** | Deselect (default): models a three-axis compass<br>Select: models a two-axis compass | | |
| **Declination angle**<br>(or magnetic variation) | Enter the value at the location of the compass sensor | | |
| | Units: radian | Range: ±π rad | Default: 0 |
| **Bias due to host vehicle equipment hard-iron magnetism** | Enter values of magnetic field within the vehicle at the location of the compass sensor | | |
| **X, Y, Z** | Units: microTesla | Range: ±10 µT | Default: 0 |
| **Scale factor, cross coupling and soft iron error matrix** | A unit-less matrix representing host vehicle equipment soft-iron magnetism and sensor errors.<br>Uses body-frame axes with columns corresponding to the (x, y, z) axes of the true magnetic flux density and rows corresponding to the axes of the (x, y, z) sensor errors. | | |
| | Main diagonal | Range: ±1.25 | Default: 0 |
| | Other elements | Range: ±0.25 | Default: 0 |
| **Quantisation** | Quantization errors occur when the sensor output is converted into an integer multiple of a constant (quantization level), for example after analog-to-digital conversion of a signal. | | |
| **Level** | Units: radian | Range: 0 to 0.5 rad | Default: 0 |
| **Carry-over residual** | The difference between the un-quantised magnetometer output vector and the quantised one.<br>Deselect (default): does not add the residual into the next epoch<br>Select: adds the residual into the next epoch | | |


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# 22.9 Barometric height

Reference rr) gives details on the baro-altimeter model.

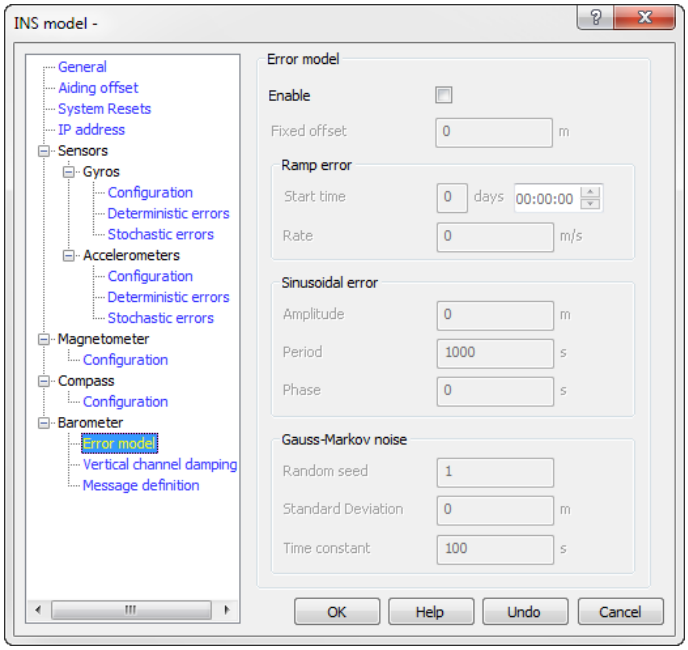
## 22.9.1 Error model

You can apply an error model to barometric height. The model provides vertical channel compensation in local INS models or for transmission to SimINERTIAL.

Baro height is included in both the “Truth Aiding EGI” and “INS Error Model” streamed messages.

This model applies errors that relate mean sea level to barometric height. You can apply all error types simultaneously. In this case, the errors will be cumulative.

This figure shows the **Error model** dialog.




| | | | |
|---|---|---|---|
| **Enable** | Deselect (default): disables error model<br>Select: enables the error model | | |
| **Fixed offset** | A constant error throughout the run | | |
| | Units: metres | Range: ± 1 000 000 m | Default: 0 |
| **Ramp error** | A linearly changing error from the given start time | | |
| **Start time** | Units: d hh:mm:ss | Range: 0 00:00:00<br>to 23 23:59:59 | Default:<br>0 00:00:00 |
| **Rate** | Units: metres per second | Range: ± 1 000 $m.s^{-1}$ | Default: 0 |
| **Sinusoidal error** | A sinusoidally varying error using these characteristics | | |
| **Amplitude** | Units: metres | Range: ± 10 000 m | Default: 0 |
| **Period** | Units: seconds | Range: 1 to 100 000 s | Default: 1000 |
| **Phase** | Units: seconds | Range: 0 to 100 000 s | Default: 0 |
| **Gauss-Markov noise** | A Gauss-Markov first-order process to add random noise to the baro-altimeter measurement | | |
| **Random seed** | Units: none | Range: 0 to 9 999 | Default: 1 |
| **Standard Deviation** | Units: metres | Range: 0 to 9 999 m | Default: 0 |
| **Time constant** | Units: seconds | Range: 1 E-6 to 9 999 s | Default: 100 |

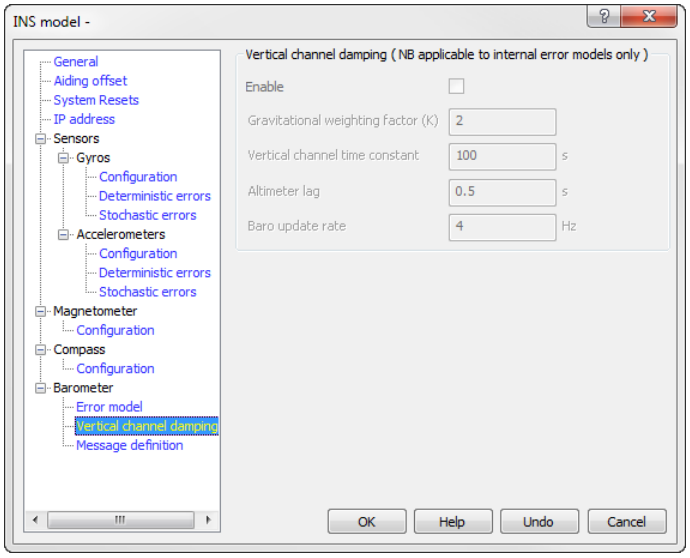

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## 22.9.2 Vertical channel damping

***Note**: Only INS model types **Strapdown** and **Space stabilised** enable **Vertical channel damping**.*

The vertical component of the INS mechanisation is unstable because a small error in determining gravity quickly accumulates into large velocity and altitude errors. Generally, using altitude aiding supplied by a baro-altimeter compensates for this.

Local INS models use SimGEN to apply third-order baro-altimeter compensation for the vertical channel. Selecting **Barometer-Vertical channel damping** displays the dialog shown below. This figure shows the dialog after selecting **INS model-General-INS model type-Strapdown** and then selecting **Enable** in the dialog.



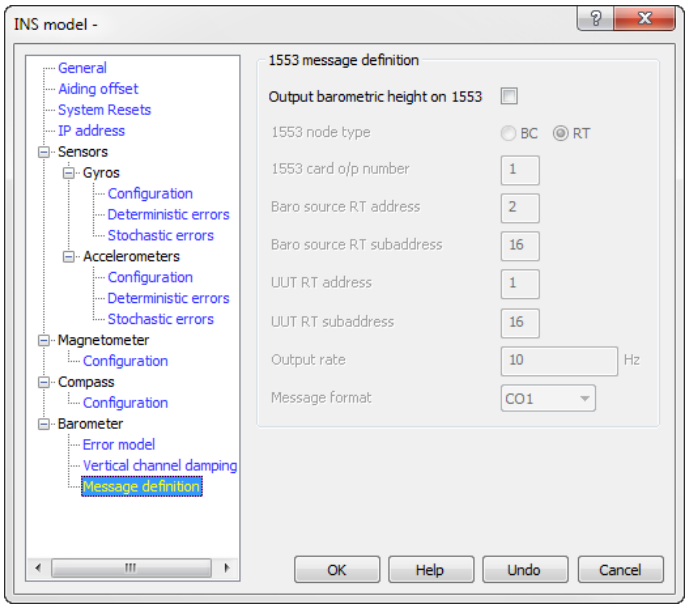

| | | | |
|---|---|---|---|
| **Enable** | Deselect (default): disables channel damping<br>Select: enables third-order vertical channel damping in determining the combined solution for system height | | |
| ***Note**: Only INS model types **Strapdown** and **Space stabilised** enable **Vertical channel damping**.* | | | |
| **Gravitational weighting factor (K)** | Determines the relative extent to which the magnitude of the geocentric position vector (r) is obtained from baro- or purely inertial data, such that:<br>$\|r\|^3 = \|r_a\|^K \|r_i\|^{3-K}$<br>Where: $r_a$ and $r_i$ are the values of the position vector, based on baro-altimeter and inertial measurements, respectively. | | |
| | Units: none | Range: 0 to 20 | Default: 2 |
| **Vertical channel time constant** | The time constant used in the vertical channel damping loop | | |
| | Units: seconds | Range: 10 to 1 000 s | Default: 100 |
| **Altimeter lag** | Dynamic lag of the transducer providing the baro-altimeter data | | |
| | Units: seconds | Range: 0.1 to 10 s | Default: 0.5 |
| **Baro update rate** | Only enabled with **INS model type-Strapdown** | | |
| | Units: Hertz | Range: 0.001 to 100 Hz | Default: 4 |



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### 22.9.3 Message definition

This figure shows the **Message definition** dialog.




| | | | |
|---|---|---|---|
| **Output barometric height on 1553** | Deselect (default): does not use barometric height model<br>Select: uses barometric height model | | |
| **1553 node type** | Select from **BC** or **RT**<br>**BC** enables **UUT RT address**, **UUT RT subaddress**<br>**RT** (default) enables **Baro source RT address**, **Baro source RT subaddress** | | |
| **1553 card o/p number** | Range: 0 to 1 | Default: 1 | |
| **Baro source RT address** | Range: 0 to 255 | Default: 2 | |
| **Baro source RT subaddress** | Range: 0 to 255 | Default: 16 | |
| **UUT RT address** | Range: 0 to 255 | Default: 1 | |
| **UUT RT subaddress** | Range: 0 to 255 | Default: 16 | |
| **Output rate** | Units: Hertz | Range: 0.01 to 100 Hz | Default: 10 |
| **Message format** | Select from the formats **CO1** (default), **CO3**, **EI30** and **AE6B-R27** | | |

### 22.9.4 INS sensor error model

The INS model introduces errors that are determined using calls to a DLL *INS Sensor Model.dll*. This DLL may be located in the folder from which the calling program (SimGEN or SimINERTIAL) runs, or in *C:\WINDOWS\system32*.

### 22.9.5 Description

The error model for the INS sensor offsets the nominal sensor inputs to produce perturbed output values. It applies the following generic model to each sensor:

Sensor output = Sensor input ($s_i$) + Sensor error (E)

Where:

Sensor input is the applicable angular velocity (gyros) or acceleration (accelerometers) along the nominal sensor input axis (“perfect” sensor data).

The direction of the input axis is in terms of the rotation of the sensor reference frame

($X_s$, $Y_s$, $Z_s$) with respect to the IMU (or vehicle) reference frame and uses the quaternion format.

***Note**: In this context, measured rotation-rate includes the effect of Earth rotation and measured acceleration includes gravity (when the term “specific force” refers to net acceleration). The latter consideration is also applicable when evaluating sensor error terms that are functions of acceleration.*

Factors used by the model:

Sensor error (E):

$$E = S.s_i + (1 + S)(M + B) + R + S_a(|s_i + M + B|)$$

Where:

S = Sensor scale factor error.

$s_i$ = “True” sensor input.

M = Misalignment error.

B = Deterministic sensor bias error

R = Random (stochastic) sensor error.

$S_a$ = Sensor scale factor asymmetry

**Sensor scale factor error (S)**

A proportional scaling offset, so the applied scale factor is effectively (1+S). It includes a constant offset term and functions of acceleration and acceleration squared:

$$S = Sx + Sfx.f_x + Sfy.f_y + Sfz.f_z + Sf^2x.f_x^2 + Sf^2y.f_y^2 + Sf^2z.f_z^2$$

Where: $f_x$, $f_y$, $f_z$ refer to acceleration (specific force) along the respective sensor axes.

Scale factor asymmetry error ($S_a$)

A similar definition to the sensor scale factor error (Sx). It accounts for situations where the scale factor is significantly different for positive or negative inputs. Spirent assumes this is independent of applied acceleration.

**Misalignment error (M)**

This results from the offset of the nominal direction of the sensor input axis ($X_s$) from its true direction. The misalignment error is defined in terms of the rotation of $X_s$ about the other two sensor axes. It includes constant and acceleration-dependent terms:

$$M = M_{xz}.s_y - M_{xy}.s_z$$

Where:

$s_y$, $s_z$ are the effective inputs along the Y and Z sensor axes.

$M_{xz}$ is the misalignment of $X_s$ about the $Z_s$ axis = $\theta_{xz} + \theta_{xz}fx.f_x + \theta_{xz}fy.f_y$

$M_{xy}$ = Misalignment of $X_s$ about the $Y_s$ axis = $\theta_{xy} + \theta_{xy}fx.f_x + \theta_{xy}fz.f_z$

The terms $\theta_{xz}$, $\theta_{xz}fx$, and $\theta_{xz}fy$ represent the constant component of the misalignment of $X_s$ about $Z_s$ and the components that are functions of acceleration along $X_s$ and $Y_s$ respectively.

There is a similar definition for the misalignment terms about $Y_s$.

**Sensor lag**

The error model applies sensor lag.

**Sensors-Gyros-*Configuration*** (page 22-7) covers sensor lag for gyros and **Sensors-Accelerometers-*Configuration*** (page 22-11) covers sensor lag for accelerometers.

**Bias terms (B)**

Bias terms include a fixed term and components due to acceleration, acceleration squared and the product of acceleration, along orthogonal sensor axes. The following equation for total bias shows the components:

| | |
|---|---|
| $B_f$ | (fixed bias term) |
| $+ Bfx.f_x + Bfy.f_y + Bfz.f_z$ | (bias proportional to acceleration) |
| $+ Bf^2x.f_x^2 + Bf^2y.f_y^2 + Bf^2z.f_z^2$ | (bias proportional to acceleration squared) |
| $+ Bfxy.f_x.f_y + Bfxz.f_x.f_z + Bfyz.f_y.f_z$ | (bias proportional to product of acceleration) |


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**Sensors-Gyros-*Deterministic errors*** (page 22-8) covers these terms for gyros and **Sensors-Accelerometers-*Deterministic errors*** (page 22-13) covers these terms for accelerometers.

**Random terms (R)**

Random terms can include the effects of adding noise, random walk and first or second-order Gauss-Markov process errors to the sensor output values.

**Sensors-Gyros-*Stochastic errors*** (page 22-10) covers these terms for gyros and **Sensors-Accelerometers-*Stochastic errors*** (page 22-15) covers these terms for accelerometers.

## 22.10 INS sensor dll

Spirent implements the operations library for the sensor error model as a Win-32 DLL.

### 22.10.1 Accessing the dll

A process requiring access to the DLL functionality loads it using a Windows system call, similar to:

```
HMODULE dll_handle = LoadLibrary( "INS Sensor Model.dll");
```

SimGEN uses special classes (for example DLL_handler) to facilitate DLL operations.

The basic method used to reference functions in a Win-32 DLL is to use the function GetProcAddress to get a pointer to the required function, for example:

```
FARPROC func_name_p = GetProcAddress ( dll_handle, func_name );
```

In this case, the DLL function is called, after casting this to the appropriate function type, as:

```
func_name_p()
```

The main SimGEN program facilitates calls to DLLs using the DLL handling classes to allow direct use of the DLL function names, as opposed to using the relevant pointers. The global pointer ins_sensor_model_gp, references the DLL, so that calls to individual library functions are of the form

```
ins_sensor_model_gp ->sensor_dll_function().
```

This does not affect the definition of the function definition within the DLL itself, though it is obviously essential the function names, return value, number of arguments and argument types must be consistent in both locations.

### 22.10.2 Interface to sensor dll functions

This table details the function calls of the operations sensor model DLL:

| Call | Description |
|---|---|
| ***get_version*** | Gets name and version number of DLL application |
| ***assign_init_data*** | Supplies sensor error coefficient data to the DLL |
| ***update_sensors*** (page 23-4) | Updates DLL with current motion and returns sensor error data |
| ***reset*** (page 23-4) | Resets the DLL at the end of the run |

#### 22.10.2.1 get_version

Declaration: `extern "C" const char *get_version ( );`

Return value: Pointer to “C” style string (null terminated) containing version of the DLL in the format "SimINSsensor vN.nn", where a change in N reflects a change in the interface to the DLL.

Usage: Called when enabling the DLL. Ensures a compatibility of the interface between the calling program and the DLL.

#### 22.10.2.2 assign_init_data

This function initialises the DLL with the relevant sensor error coefficients for each sensor, as follows:

Declaration: `extern “C” void assign_init_data (INS::Sensor_dll_init_data &init)`

Return value: None

Arguments: A structure, passed by reference, defining the control data of the INS sensor model:

```
enum { num_sensors = 6 };// 6 gyros + 6 accelerometers
enum sensor_type { gyro_type, accel_type, num_types };

struct Sensor_dll_init_data
```


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```
{
  double sensor_update_rate_hz_d;
  int veh_index_i;
  int spare_i;
  Sensor_error_coefficients sensor_error_coeffs[num_sensor_types][MAX_NUM_SENSORS];
};
```

The elements of this structure:

`sensor_update_rate_hz_d`: The DLL sensor data update rate, in Hz.

`veh_index_i`: The index of the simulated vehicle for which the initialisation data applies. (Starts at zero for vehicle 1).

`Sensor_error_coefficients`: Defines the data for the sensor error coefficients, for both sensor (gyros and accelerometers) types. This array may contain data for up to six instruments (0-5) for both sensor types (gyro_type=0, accel_type=1).

The following code defines this structure:

```
struct Sensor_error_coefficients
{
  Sensor_error_coefficients();

  double  output_scaling_d;  // Output Scale factor
  double  quaternion_ad[4];  // Quaternion elements
  double  theta_xy_d;     // Misalignment x about y
  double  theta_xz_d;     // Misalignment x about z
  double  theta_xy_f_x_d; // Misalignment x about y
                  // for force along x
  double  theta_xz_f_x_d; // Misalignment x about z
                  // for force along x
  double  theta_xy_f_z_d; // Misalignment x about y
                  // for force along z
  double  theta_xz_f_y_d; // Misalignment x about z
                  // for force along y
  double  sf_error_d;     // Scale factor error
  double  sf_asymmetry_d; // Scale factor asymmetry (ratio)
  double  sf_error_f_x_d; // Scale factor error for
                  // force along x
  double  sf_error_f_y_d; // Scale factor error for
                  // force along y
  double  sf_error_f_z_d; // Scale factor error for
                  // force along z
  double  sf_error_f2_x_d;   // Scale factor error for
// force**2 along x
  double  sf_error_f2_y_d;   // Scale factor error for
                  // force**2 along y
  double  sf_error_f2_z_d;   // Scale factor error for
                  // force**2 along z
  double  fixed_offset_d; // Fixed error term
  double  offset_f_x_d;   // Offset for force along x
  double  offset_f_y_d;   // Offset for force along y
  double  offset_f_z_d;   // Offset for force along z
  double  offset_f2_x_d;     // Offset for force**2
                  // along x
  double  offset_f2_y_d;     // Offset for force**2
                  // along y
  double  offset_f2_z_d;     // Offset for force**2
                  // along z
  double  offset_f_xy_d;     // Offset for product of
                  // force along x and y
  double  offset_f_xz_d;     // Offset for product of
                  // force along x and z
  double  offset_f_yz_d;     // Offset for product of
                  // force along x and z
  double  random_walk_psd_d; // Random walk error power
                  // spectral density (psd)
  double  rate_random_walk_psd_d; // Random walk error
                  // psd for ang-rate/accel.
  double  gm1_tc_d;       // Gauss-Markov 1st order
                  // time constant
  double  gm1_psd_d;   // Gauss-Markov 1st order
```


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```
                // psd
  double  gm2_damping_d;     // Gauss-Markov 2nd order
                // damping factor
  double  gm2_omega_d;    // Gauss-Markov 2nd order
                // natural frequency
  double  gm2_psd_d;    // Gauss-Markov 2nd order
                // psd
  double  latency_ms_d;   // Sensor latency in ms
  int   seed_rw_i;    // Seed value for random
           // walk process
  int   seed_rrw_1_i;   // 1st seed value for rate
           // random walk process
  int   seed_rrw_2_i;   // 2nd seed value for rate
           // random walk process
  int   seed_gm1_i;     // Seed value for GM1
           // process
  int   seed_gm2_i;     // Seed value for GM2
           // process
  bool  used_b;       // Denotes which sensors are
           // defined!
};
```

DLL Operations:Assigns the error coefficient data for each sensor in use, zeroes errors, and initialises random processes and transformation matrices.

Usage: Called by SimGEN (INS error model) or from SimINERTIAL at the start of the run.

#### 22.10.2.3 update_sensors

Declaration: extern “C” bool update_sensors( Sensor_errors &sensor_err, int veh_index )

Return value: bool (true or false). False indicates an error has occurred.

Arguments:

(i) Structure, that is passed by reference, contains motion data to determine sensor errors and return the sensor error values. It is defined as follows:

```
struct Sensor_errors
{
   double time_in_run_s_d;
   double applied_accel_vd[3];
   double applied_rotation_rate_vd[3];
   double sensor_output_ad [ num_types ][ num_sensors ];
   double sensor_error_ad [ num_types ][ num_sensors ];
};
```

(ii) Integer designating applicable vehicle index in a multi-vehicle configuration. vehicle 1 has an index value of zero.

DLL Operations:Resolves the applied acceleration and rate vectors in terms of the actual sensor axes, for each sensor. The input motion is with respect to the ECI frame (and should contain Earth rotation and gravitational effects) and is resolved along the platform (IMU) reference axes.

It determines the current sensor error as a function of the input dynamics for each enabled sensor and returns this information, and the perturbed output values, to the calling program.

This data is in terms of instantaneous acceleration and angular rate, and not $\Delta V$ and $\Delta\theta$ terms directly.

Usage: Called by SimGEN (INS error model) or from SimINERTIAL, for each update of the sensor output data.

#### 22.10.2.4 reset

Declaration: `extern "C" void reset ( );`

Return value: None

Usage: Called at the end of the run to ensure the DLL frees all additional memory it has requested.

## 22.11 Differences between VMS and Windows models

***Note**: Both SimGEN and SimGEN for VMS equate the magnetic heading to the true heading.*

Reference tt) describes the mathematics used in the space-stabilised INS model.


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This list details the differences between the space-stabilised models implemented in SimGEN for VMS and SimGEN for Windows:

→ SimGEN for Windows can send one message.
The message contains all parameters
You can choose the time interval between the messages
SimGEN for VMS can send up to four messages
You can choose the content of each message from the available parameters
You can select the time interval between each message of the same type

→ SimGEN for Windows calculates the aiding motion at each time interval between the start- and end-points
SimGEN for VMS calculates the aiding motion at the start- and end-points and interpolates between these points

→ SimGEN for Windows incorporates five different gravity models
SimGEN for VMS uses a fixed value for g of 9.81 $ms^{-2}$

→ SimGEN for Windows propagates the INS platform at the sensor update rate
SimGEN for VMS propagates INS Motion at 10 Hz


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# 23 Receive and transmit antennas

This Chapter describes the SimGEN receive antenna and its default orientation and location, details how you set up your scenario to associate a GNSS signal with the receive antenna and how you position a GNSS antenna on a vehicle. Finally, it details using transmitter antenna patterns.

From version 3-00 onwards, SimGEN supports one transmitter antenna pattern, per satellite, per constellation.

From version 5.04SR01 onwards and only for GSS9000-series signal generators, SimGEN supports transmitter antenna phase patterns.

From PosApp version 6-00 onwards, the GSS7000 supports transmitter antenna phase and level patterns.

## 23.1 Receiver antennas

***Notes**:*

***1)** SimGEN numbers vehicles and antennas from one*

***2)** SimGEN treats each receiver antenna as completely independent*

***3)** You can delete all antennas, except that for Vehicle 1, Antenna 1*

You can use more than one receiver antenna with multiple-output signal generators, such as the dual-output GSS9000-series signal generators. You can associate each antenna with different GNSS signals, position each antenna in different locations on the vehicle and apply different offsets to each antenna.

This table details the convention SimGEN uses for naming antennas on vehicles, with examples. ***Vehicle models*** (page 21-1) describes adding vehicles to a scenario.

| Description | SimGEN Vehicle | SimGEN Antenna | Example |
|---|---|---|---|
| One vehicle, one antenna (default) | Vehicle 1 | Antenna 1 | Aircraft with GPS L1 constellation |
| One vehicle, two antennas | Vehicle 1<br>Vehicle 1 | Antenna 1<br>Antenna 2 | Aircraft with GPS L1 constellation and WAAS L1 constellation; or<br>Aircraft with GPS L1 constellation using an antenna on each of two wing-tips |
| Second vehicle, one antenna | Vehicle 2 | Antenna 1 | Land vehicle with GLONASS L1 constellation |
| Second vehicle, two antennas | Vehicle 2<br>Vehicle 2 | Antenna 1<br>Antenna 2 | Land vehicle with GLONASS L1 constellation<br>and Galileo OS E1 constellation; or<br>Land vehicle with GLONASS L1 constellation using one windscreen and one roof antenna |

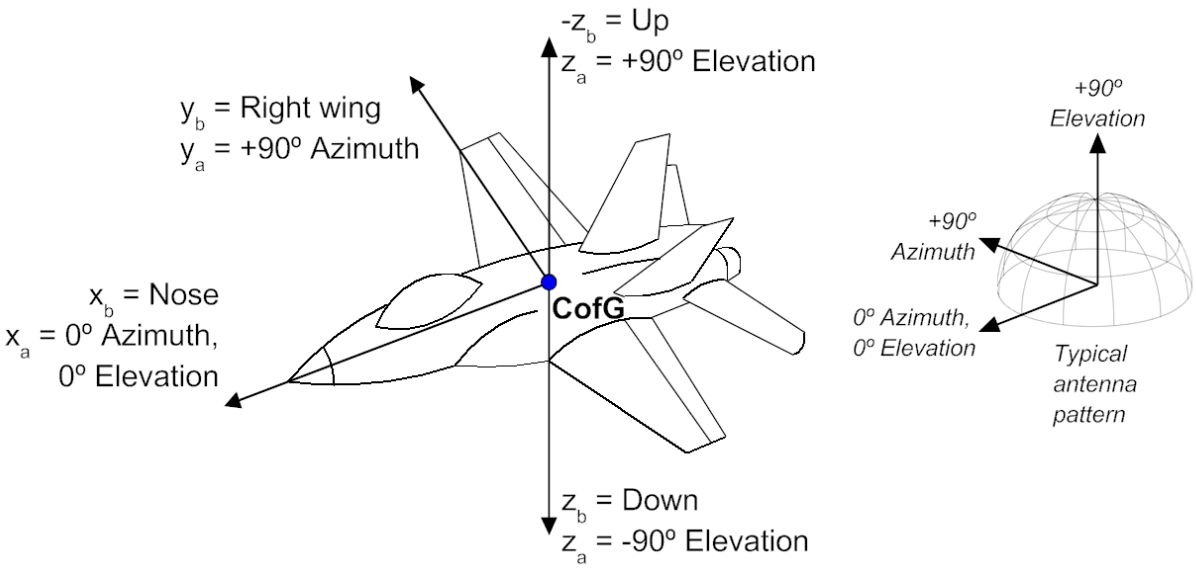
You can label each antenna by selecting the antenna in the **Scenario contents** window, right-clicking and selecting **Label**.

### 23.1.1 Default receiver antenna orientation

***Note**: The figures in the following sections use subscript 'a' to refer to antenna and 'b' to refer to vehicle body.*

By default, SimGEN sets the antenna position and angular offsets to zero. Spirent's convention is for zero degrees antenna azimuth and zero degrees antenna elevation to lie along the vehicle x- axis, $x_b$ in the figure below. This figure shows a typical hemispherical antenna pattern with its axes. Placing this antenna on the vehicle shows the default alignment of the antenna pattern axes and the vehicle axes.


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Ignoring antenna angular offsets, Spirent uses the following conventions for receiver antenna azimuth and elevation:

- 0.0° Azimuth, 0.0° elevation in the grid of the antenna pattern editor is along the vehicle's x-axis. This is normally towards the front of the vehicle, which is NOT necessarily the direction of travel.
- Looking from above, positive azimuth is a clockwise rotation in the vehicle's x-y plane.
- For receiver antenna patterns, positive elevation is towards the negative z-axis.
- For a typical receiver antenna pattern, the direction of maximum antenna gain (the boresight) will be at 90° elevation in the grid of the antenna pattern editor.

In addition, the following defaults apply:

- The lever arm offset [x,y,z] = [0,0,0]
- heading ($\psi_a$) = elevation ($\theta_a$) = bank ($\phi_a$) = 0

By default, Spirent locates the antenna at the vehicle CofG see the figure above. You can offset the position of the antenna from the CofG along each body axis, and offset the angular position by rotating the antenna pattern from its default. The antenna reference axis set ($x_a$, $y_a$, $z_a$) will be coincident with the vehicle body frame, by default. Spirent define angular offsets as a sequence of Euler angle rotations of the antenna pattern frame in heading ($\psi_a$), elevation ($\theta_a$), and bank ($\phi_a$), as for body attitude with respect to local level, see the examples in the following sections.



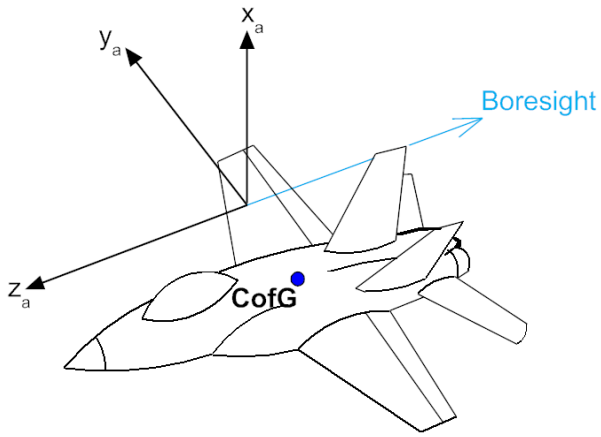
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### 23.1.2 Antenna Offset example 1

This figure shows the antenna boresight pointing aft, with the antenna mounted two metres out on the starboard wing. Lever arm offset in body frame = [0, 2.0, 0]

$\psi_a = 0$, $\theta_a = 90°$, $\phi_a = 0$

***Note**: This figure assumes the antenna boresight is at 90.0° elevation in the antenna pattern*

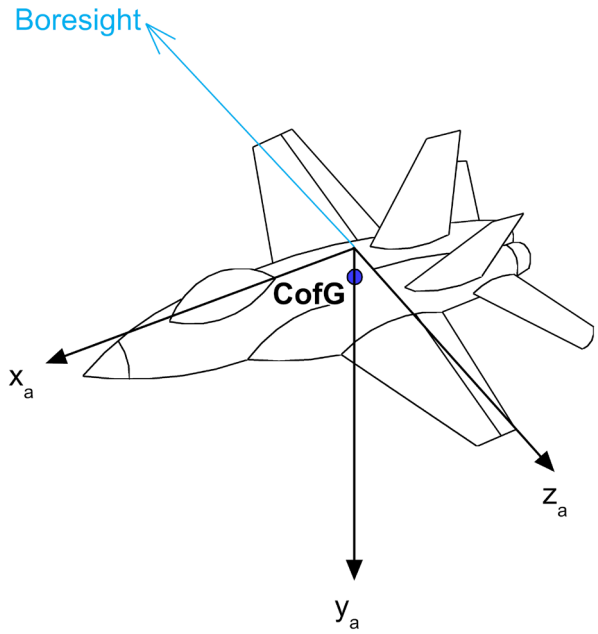



### 23.1.3 Antenna Offset example 2

This figure shows the antenna boresight pointing starboard, with antenna mounted above the CofG by 0.5 metres. Lever arm offset in body frame = [ 0, 0, -0.5]

$\psi_a = 0$, $\theta_a = 0$, $\phi_a = +90°$

***Note**: This figure assumes the antenna boresight is at 90.0° elevation in the antenna pattern*





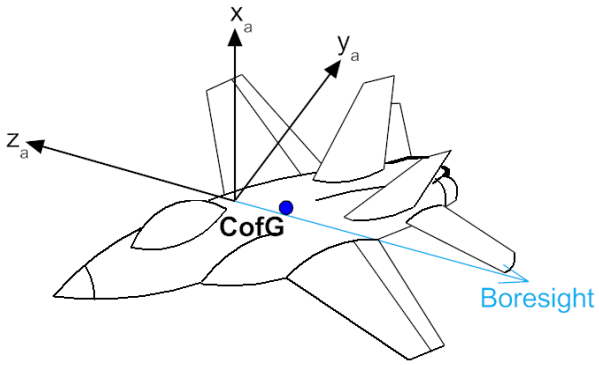
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### 23.1.4 Antenna Offset example 3

This figure shows the antenna boresight in the vehicle's x-y plane pointing aft, but at +45° to the x-axis of the body and the antenna mounted 1.0 metres in front and 0.5 metres above CofG. Lever arm offset in body frame = [1.0, 0, -0.5]

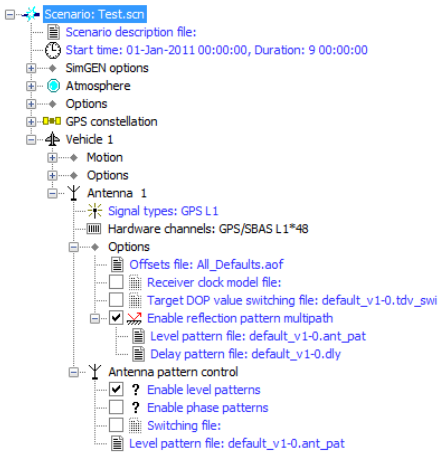
$\psi_a$ = +45°, $\theta_a$ = +90°, $\phi_a$ = 0

***Note**: This figure assumes the antenna boresight is at 90.0° elevation in the antenna pattern*




### 23.1.5 Associate a GNSS signal with an antenna

You must associate at least one GNSS signal type with each antenna. Working in the **Scenario Contents** window, expand **Vehicle**, then **Antenna** to show **Signal types**, this figure shows **Vehicle1-Antenna1**.




The following steps show associating **GPS L1** with **Vehicle 1-Antenna 1**.

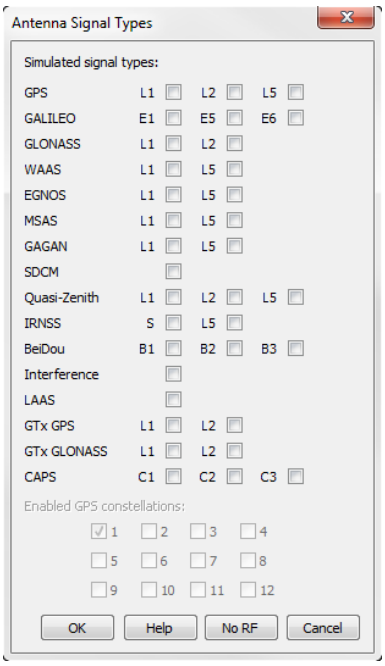
→ Select **Antenna 1-Signal types**.

→ Right-click and select **Edit**.

→ Select **GPS L1** from the **Antenna Signal types** dialog



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→ Click **OK**.

You must ensure your signal generator configuration supports all the constellations and antennas you select. The menu item **Options-*Change Hardware Configuration*** (page 5-35) details changing your signal generator configuration.

***Multiple GPS Constellations*** (page 10-1) details using the licenced feature of multiple GPS constellations.

#### 23.1.5.1 Adding / changing signal types at an antenna

The previous section associated GPS L1 signals with Antenna 1. Depending on the capability of your signal generator, you can associate other signal types with the antenna. For example, use these steps to associate a new signal type with Antenna 1:

→ Select **Antenna 1-Signal types**.

→ Right-click and select **Edit**.

→ Select the signal type you want to use from the list of signal types.

→ Click **OK**.

→ As before, you must ensure your signal generator supports all the constellations and antennas you select.

#### 23.1.5.2 Add a second antenna

To add a second antenna to a scenario, follow these steps:

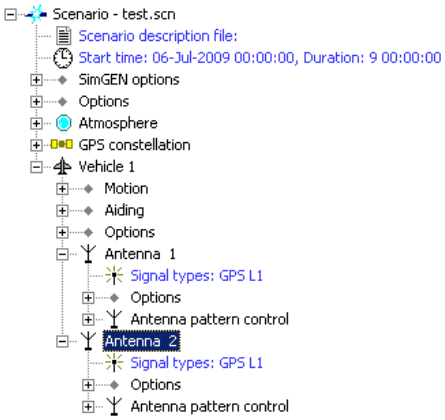
→ Use the menu item **Options-*Change Hardware Configuration*** (page 5-35) to select an appropriate configuration, for example two GSS8000 signal generators.

→ In the **Scenario Contents** window, select **Vehicle 1-Antenna 1**.

→ Click **New**.

→ **Antenna 2** appears under **Vehicle 1**:


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Using a valid configuration, such as two GSS8000-series signal generators, SimGEN automatically maps the new antenna and vehicle to the signal generators.

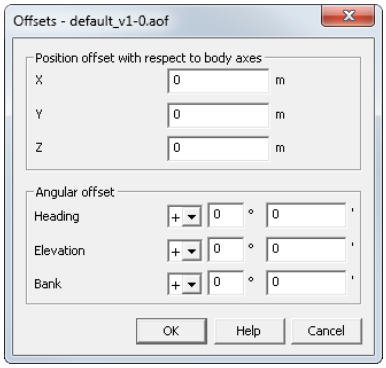
## 23.1.6 Options

This section describes applying options to an antenna. With a multiple-output signal generator, you can apply different options to each antenna on the vehicle.

### 23.1.6.1 Offsets file

***Note**: **Switching receiver antenna offset** (page 23-19) will override any settings in the **Offsets file**.*

Offset the antenna position and orientation from the default setting for the duration of the scenario using **Vehicle-Antenna-Options-Offsets file**, see the dialog below. Use ***Switching receiver antenna offset*** to offset the antenna pattern at specific times during a scenario.



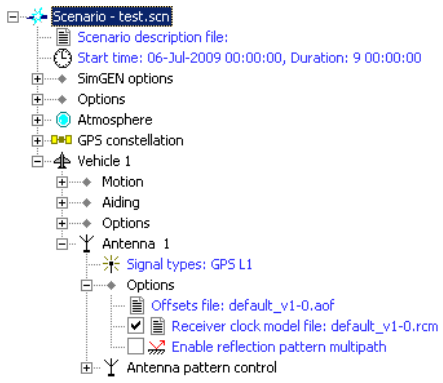

| | | | |
|---|---|---|---|
| **Position offset** | Offsets the antenna position from the vehicle's CofG | | |
| **X, Y, Z** | Units: metres | Range: ± 500 m | Default: 0 |
| **Angular offset** | Rotates the antenna orientation from the default setting | | |
| **Heading**<br>**Elevation**<br>**Bank** | Units: degrees, minutes | Range: ± 180° | Default: 0 |

### 23.1.6.2 Receiver clock model

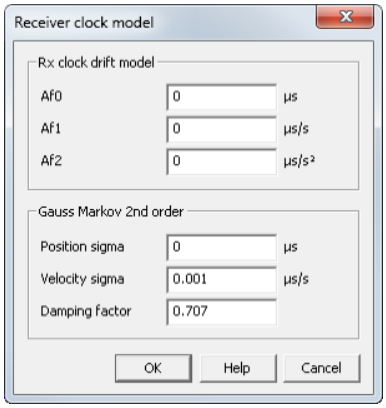
SimGEN incorporates this model into the pseudorange of each satellite associated with the antenna.

First, expand **Vehicle-Antenna-Options**, see the figure below, and select **Receiver clock model file:**. A tick in the checkbox confirms your selection. The default **Receiver clock model** filename is *default_vx-yy.rcm*.


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Now set the model coefficients. You can use a quadratic model, a Gauss-Markov second-order model, or both models. Highlight and double-click **Receiver clock model file** to open the **Receiver clock model** dialog and type values for the appropriate coefficients:

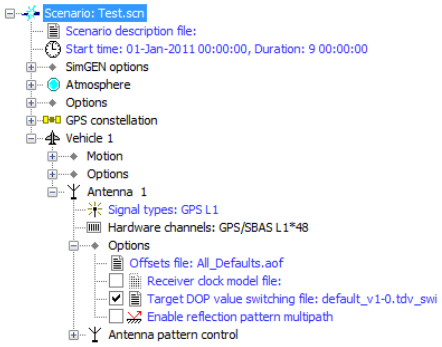



| | | | |
|---|---|---|---|
| **Rx clock drift model** | Set the quadratic coefficients of the receiver clock drift model<br>***Note**: The default values set the model to zero* | | |
| **Af0** | Units: microseconds | Range: ±100 µs | Default: 0 |
| **Af1** | Units: microseconds per second | Range: ±0.007 4 $\mu s.s^{-1}$ | Default: 0 |
| **Af2** | Units: microseconds per $(second)^2$ | Range: ±1 E-06 $\mu s.s^{-2}$ | Default: 0 |
| **Gauss-Markov 2nd order** | Set the Gauss-Markov second order coefficients of the receiver clock drift model<br>***Note**: The default values set the model to zero* | | |
| **Position sigma** | Units: microseconds | Range: 0 to 100 µs | Default: 0 |
| **Velocity sigma** | Units: microseconds per second | Range: 0.001 to 1 $\mu s.s^{-1}$ | Default: 0.001 |
| **Damping factor** | Units: none | Range: 0.001 to 0.999 | Default: 0.707 |

### 23.1.6.3 Target DOP value switching file

Click in the box to enable **Target DOP value switching file**, a tick in the checkbox confirms your selection.

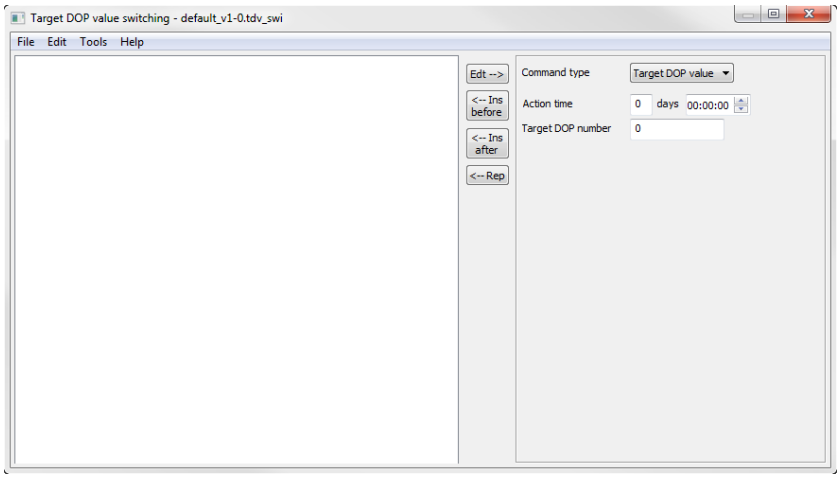

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This switching file sets a **Target DOP number** at an **Action Time** you specify using the SimGEN ***List Editor*** (page 5-33).

At **Action time**, SimGEN orders the DOP table in in ***Sky Plot*** (page 3-4) so that the best set is closest to **Target DOP number**.

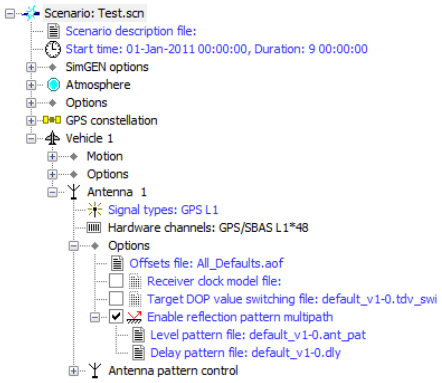
To turn off **Target DOP number** during a run, set **Target DOP number** to zero




| | | | |
|---|---|---|---|
| **Action time** | Units: d hh:mm:ss | Range:<br>0 days 00:00:00<br>to 23 days 23:59:59 | Default: 0 days 00:00:00 |
| **Target DOP number** | Default: 0<br>Type the **Target DOP number** you want to use at an **Action Time** | | |

### 23.1.6.4 Reflection pattern multipath

Click in the box to enable **Reflection pattern multipath**, a tick in the checkbox confirms your selection. The figure below shows the default files for the **Level pattern file**, *default_vx-yy.ant_pat*, and the **Delay pattern file**, *delay_vx-yy.dly*. Double-click the file you want to edit. **Channel assignment and multipath types-*Reflection pattern multipath*** (page 24-15) describes setting the Reflection pattern parameters.





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## 23.2 Antenna patterns

***Notes**:*

***1)** This section refers to level pattern files that define antenna pattern gain. Spirent uses the convention that positive values refer to attenuation and negative values refer to amplification.*

***2)** The RF power level you specify in the GNSS constellation file assumes the antenna level pattern has 0 dB gain. If you use a non-zero antenna level pattern, the signal level at the signal generator output port is the RF power level you specify in the satellite constellation file, modified by the gain (or attenuation) from the antenna level pattern.*

At each simulated carrier frequency, SimGEN supports up to four separate receiver antenna patterns (located on the vehicle); and four separate transmitter antenna patterns (located on the satellite).

Generally, to use these patterns:

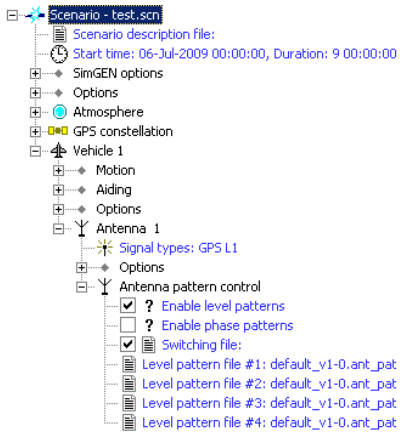
→ To set up and edit each receive antenna, expand **<vehicle>** and use **Antenna *n*-Antenna pattern control**. This table details the relevant sections for receiver antennas:

| Level patterns | Phase patterns | Switching patterns |
|---|---|---|
| ***Receiver antenna level pattern*** (page 23-9) | ***Receiver antenna phase pattern*** (page 23-16) | ***Switching receiver antenna pattern and offset*** (page 23-18) |
| Supports up to four patterns | Supports up to four patterns | Switches between different level patterns and different phase patterns |

→ To set up and edit each transmitter antenna, expand **<constellation>** and select **Enable Tx antenna patterns**. ***Transmitter antenna level and phase patterns*** (page 23-20), describes setting transmitter antenna level and phase patterns, which use the same editors as the receiver antenna..

For each receiver antenna, you can create up to four separate level patterns (antenna gain patterns), using the default level pattern file (*default_vx-yy.ant_pat*, which is the level pattern of an isotropic antenna with 0 dB gain) as the basis for each antenna level pattern file; and four separate phase patterns, see the figure below.

Use ***Switching receiver antenna pattern and offset*** to switch between receiver antenna patterns at times you specify.




The SimGEN antenna level pattern and phase pattern files define the directional variation in gain (level pattern) and phase (phase pattern) of the simulated receiver and transmitter antennas. The level pattern and phase files consist of an array of values in definable cell widths indexed by elevation and azimuth angle. The level pattern and phase pattern cover ± 90 degrees in elevation, and ±180 degrees in azimuth.

For example, you can create a receiver antenna level pattern file (using a name of your choice ) that simulates the signal level from a satellite (or interference signal) varying with the angle of incidence at the receiver antenna.

### 23.2.1 Receiver antenna level pattern

***Notes**:*


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***1)*** *See* ***Azimuth resolution and Elevation resolution*** *(page 23-13) if you use an azimuth or elevation interval less than the default 5 degrees*

***2)*** *The default receiver antenna level pattern file, default_vx-yy.ant_pat, refers to an isotropic (zero attenuation) radiator.*

The level pattern file contains gain values for the antenna at the discrete angular intervals in the azimuth and elevation ranges shown in this table and represents the amplitude response of the antenna when mounted on the vehicle. For example, you can include the obscuration of the satellite signal by an aircraft fuselage.

| Parameter | Range |
|---|---|
| Azimuth range | -180° to +180°, in steps of the Azimuth interval |
| Azimuth interval | 5° (default), 4°, 3°, 2°, 1° |
| Elevation range | -90° to +90°, in steps of the Elevation interval |
| Elevation interval | 5° (default), 4°, 3°, 2°, 1° |
| Attenuation range | -20.0 to +99.9 dB, in 0.01 dB steps.<br>***Note****: Negative numbers indicate amplification, positive numbers indicate attenuation.* |

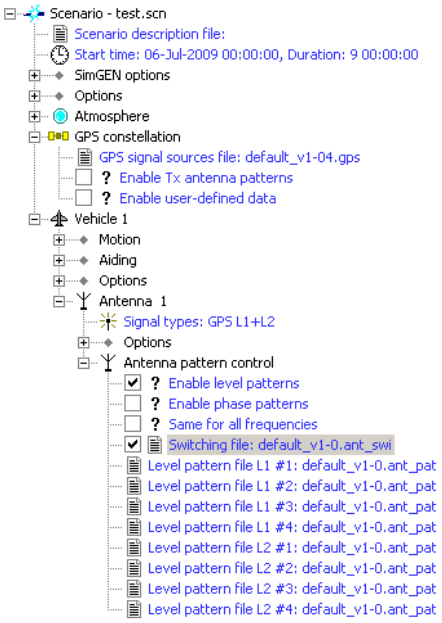
### 23.2.1.1 Antenna level pattern file editor

***Notes****:*

***1)*** *You can apply offsets in the level pattern. For example, if a cell is set to an attenuation of 20 dB you can apply a negative offset (that is, gain) of 5 dB for an overall attenuation of 15 dB or a positive offset (attenuation) of 5 dB to increase the attenuation to 25 dB.*

***2)*** *You can prepare separate* ***Antenna level pattern*** *files for each antenna on your vehicle*

This figure shows **Antenna 1-Antenna pattern control** fully expanded in the **Scenario contents** window. This example scenario does not use **Same for all frequencies**, so there is a separate level pattern file for each frequency




To edit the level pattern:

- → Select **Enable level patterns**
- → Select a **Level pattern file**. In the figure above, L1 uses *default_vx-yy.ant_pat*
- → Right-click and select **Edit**
- → The **Antenna Pattern Editor** opens

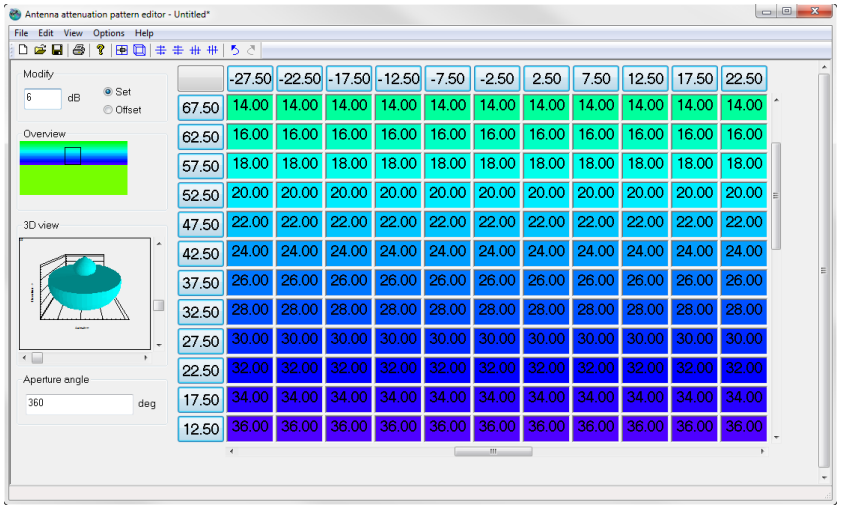

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→ the following two figures show the **Antenna Pattern Editor** for an isotropic and non-isotropic antenna

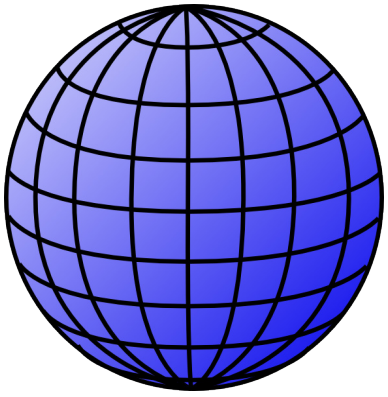
→ If your scenario uses two or more frequencies, you will see **Same for all frequencies**. To use a single antenna pattern for all frequencies from this constellation (for example, GPS L1 and L2) select **Same for all frequencies**




***Note**: Negative numbers indicate amplification, positive numbers indicate attenuation.*



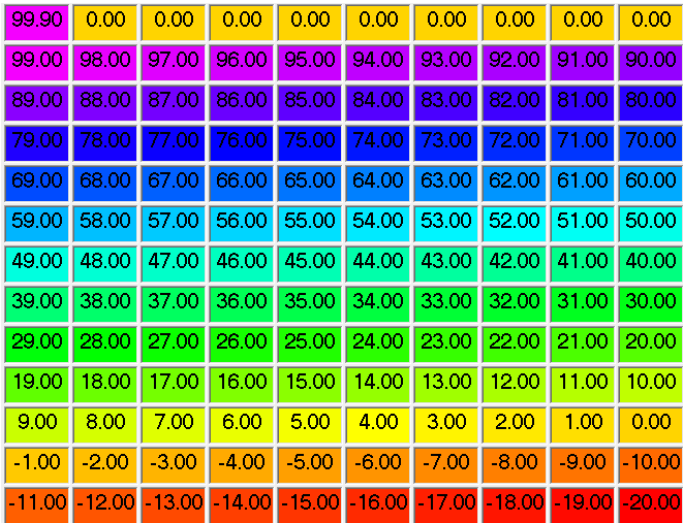

The **Antenna Pattern Editor** displays “cells” of attenuation (to two decimal places), using columns of fixed azimuth (range -180 to +180°) at intervals of five degrees, and rows of fixed elevation (range +90° to -90°) at intervals of five degrees. The azimuth and elevation angles shown in the row and column headers are the central values of each cell. You can change attenuation value in each cell. ***Azimuth resolution and Elevation resolution*** (page 23-13) details changing the resolution from the default 5 degree step. This figure shows the change in cell size and shape as the elevation moves nearer to +90° (or -90°).



The Antenna Pattern Editor uses the colour coding in this figure:

***Note**: Negative numbers indicate amplification, positive numbers indicate attenuation.*


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Follow the steps below to use the **Antenna Pattern Editor** to “paint” level patterns onto the azimuth versus elevation display by setting the value of a cell and dragging this cell over the required cells:

- In the **Modify** text box, type a value for the attenuation you want to “paint”.
- Select **Modify-Set** or **Modify-Offset**.
- “Paint” this value into other cells by selecting a cell and dragging over the required cells.
- Alternatively, set level values for complete columns of elevation or rows of azimuth by clicking on the appropriate elevation or azimuth headers at the top or left-hand side of the edit area.
- Repeat these steps for each level value you want to use.
- As you “paint” level values in the right-hand area, the diagram in the **3D View** updates to show the overall effect of your changes. ***Antenna pattern 3-D display*** (page 23-14) details the **3D View**.

The **Overview** in the left-hand corner of the Editor allows you to view the full pattern. A box outline denotes the area shown in the right-hand area. The box moves around the overview as you use the scroll-bars to move the Az and El cursors. Alternatively, ***Antenna level pattern file*** (page 23-10) describes using a spreadsheet to create an antenna pattern.

Save the antenna pattern you create by clicking on **File-Save As…** which saves the file with the **.ant_pat* extension.

This table describes the buttons in the **Antenna pattern editor** toolbar:

| Button | Reference |
|---|---|
|  | Displays the whole antenna pattern |
|  | ***Antenna pattern 3-D display*** |
|  | Mirrors the upper portion of the antenna pattern (Elevations from 90° to 0 into the lower portion) |
|  | Mirrors the lower portion of the antenna pattern (Elevations from -90° to 0 into the upper portion) |
|  | Mirrors the left portion of the antenna pattern (Azimuths from -180° to 0 into the right portion) |
|  | Mirrors the right portion of the antenna pattern (Azimuths from 180° to 0 into the left portion) |
|  | Undoes the last change made.<br>You can only use a single undo operation |
|  | Reads the file back in from disk.<br>Undoes all changes made since the last File-Save. |


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**Select an entire row or column** by clicking on the row or column header button. Select a range by pressing Shift and clicking on a second row or column header button.

**Change view in terms of azimuth and elevation** by using the scroll-bars at the right and at the bottom of the data entry area.

**Set selected fields to a given gain figure** by selecting **Modify-Set**, selecting the field(s), typing a value in **Modify** and pressing Return.

**Apply an offset to selected fields** by selecting **Modify-Offset**, selecting the field(s), typing a value in **Modify** and pressing Return.

Use **File-Save** to save your new pattern, **.ant_pat*, with a name of your choice (Notice ***Transmitter antenna level and phase patterns*** (page 23-20) also use the **.ant_pat* extension).

### 23.2.1.2 Azimuth resolution and Elevation resolution

***Note for users of GSS9000-series and GSS7000 signal generators:***

*SimGEN processes the antenna level pattern file at the Simulation iteration rate you set in the menu item* ***Options-General Options-Simulation iteration rate*** *(page 5-15).*
*GSS9000-series signal generators support* ***Simulation iteration rate*** *up to 1 millisecond*
*GSS7000 signal generators support* ***Simulation iteration rate*** *of 10 and 100 millisecond*

***Note for users of GSS8000-series, GSS7xxx and the superseded GSS7xxx, GSS4x and STR series signal generators****:*

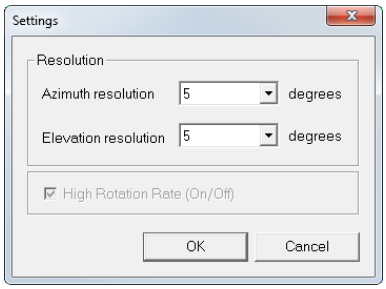
*You can select whether SimGEN processes the antenna level pattern file at the Simulation iteration rate; or whether SimGEN sends antenna pattern file data (at five-degree intervals) to the signal generator for processing at the firmware-processing rate, which is faster than the Simulation iteration rate. For example, if the rotation-rate of your vehicle exceeds one revolution per second, Spirent recommends you retain the default selection of* ***High Rotation Rate****.*

***Notes for users of GSS6700 and the superseded GSS6560 and GSS5060, signal generators****:*

***1)*** *SimGEN processes the antenna level pattern file at the rate set in the menu item* ***Options-General Options - Simulation iteration rate*** *(page 5-15)*

***2) High Rotation Rate*** *is not applicable to these signal generators*

These settings let you change the azimuth and elevation resolution from the default 5 degrees. In the Antenna attenuation pattern editor, to open the **Settings** dialog click on **Options-Settings**:




Selecting values of **Azimuth Resolution** or **Elevation Resolution** less than 5 degrees enables **High Rotation Rate (On/Off)**, and processing depends on your signal generator:

→ If you use a GSS9000-series, or GSS7000, signal generator.
SimGEN carries out **High Rotation Rate** processing at the simulation iteration rate you set for your scenario, see **Options-*General Options*-Simulation iteration rate** (page 5-15).

→ If you use a GSS8000, and earlier, signal generator:
**High Rotation Rate (On/Off)** (selected by default) enables simulation of antenna level patterns. Your signal generator determines the rate and processing method, see Notes above and the table below.
However, to use high rotation rates requires signal generator firmware processing that must use an antenna level pattern file with five-degree intervals. The following table details how the antenna pattern angular interval and selection of **High Rotation Rate** determine where the antenna level pattern processing takes place.
In all cases, you must correctly set menu item **Options-*General Options*-Simulation iteration rate** (page 5-15) (the rate SimGEN calculates and updates data).


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| Antenna pattern angular interval | High Rotation Rate | Description |
|---|---|---|
| 5 degrees (default) and using firmware-processing | Permanently selected (On) | SimGEN downloads the antenna level pattern to the signal generator firmware, which processes the antenna level pattern, calculating and updating the signal level information at the firmware processing rate. |
| Less than 5 degrees and USING firmware-processing | Selected (On) | If the antenna level pattern file contains data that does not correspond with a regular cell separation of five degrees, SimGEN processes this data to create a pattern with the required cell size. SimGEN then downloads the five-degree pattern (either the original data or SimGEN processed data) to the signal generator, which uses this data to update the signal level information at the firmware-processing rate. |
| Less than 5 degrees and NOT using firmware-processing | Deselected (Off) | SimGEN processes the antenna level pattern file. SimGEN also calculates and updates the signal level information at the Simulation Iteration Rate. |
| Firmware-processing not available | n/a | SimGEN processes the antenna level pattern file. SimGEN also calculates and updates the signal level information at the Simulation Iteration Rate. |

This table shows processing rates:

| Firmware processing rate, milliseconds | Simulation iteration rate, milliseconds | Supported by |
|---|---|---|
| Processed by SimGEN | up to 1 | GSS9000-series |
| Processed by SimGEN | 100 and 10 | GSS7000 |
| 1 | 10 and 4 | GSS8000-series<br>GSS77xx Variant B only |
| 2 | 10 | STR47xx (GPS only) - superseded<br>GSS 77xx Variant A - superseded |
| 4 | 100 | STR47xx - superseded |

The details on antenna level patterns in this section also apply to ***Receiver antenna phase pattern*** (page 5-15). If your application uses high rotation rates (for example, greater than 0.1 revolutions per second) and carrier phase patterns, contact Spirent Global Services.

#### 23.2.1.3 Antenna pattern 3-D display

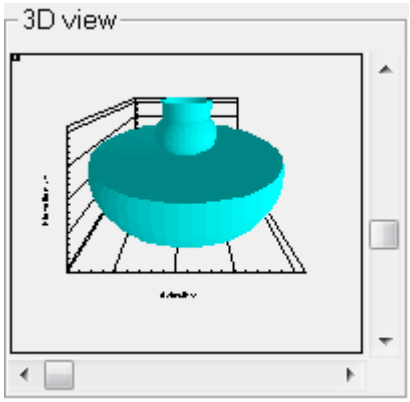
***Note**: The 3-D display does not reflect the settings you make for **Aperture angle** (page 23-15)*

This figure shows the 3-D view in the antenna pattern editor. This aids visualisation of the antenna pattern display.

See a larger view using **View-3D view** or click on the  toolbar button. The scroll-bars move the 3-D view in azimuth and elevation.

Double-clicking the 3-D display animates the image, double-click again to stop the animation.


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### 23.2.1.4 Aperture angle

***Notes**:*

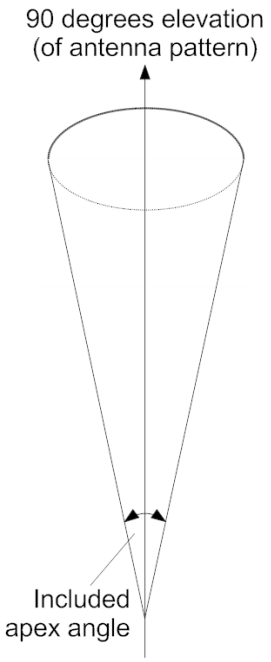
***1) Aperture angle** is only valid for receiver antennas.*

***2)** The 3-D display does not reflect any **Aperture angle** settings*

**Aperture angle** is a simple method of applying antenna obscuration to filter visible satellites. In particular, **Aperture angle** may be useful for space-borne receivers where the number of available satellites may be significantly larger than the number of signal generator channels. However, a better method is to use received power level to select satellites automatically, as this takes into account the transmitter gain. See, for example, **GPS-*Satellite selection*-Selection method-Power level** (page 10-10).

The aperture angle is equivalent to the included apex angle of a cone placed symmetrically about the direction of maximum antenna gain. SimGEN does not simulate satellite signals that fall outside this cone, even if they are physically visible to the unobstructed antenna on the vehicle.

Aperture angle range: 10° to 360° Default: 360°




### 23.2.1.5 Antenna level pattern using a spreadsheet

***Note**: Negative numbers indicate amplification, positive numbers indicate attenuation.*

You can edit the antenna level pattern using a spreadsheet or you may have antenna level pattern data in a comma-separated variable (**.csv*) format. The antenna level pattern editor can import antenna patterns using the **.csv* format. Spirent uses ASCI XML format for the **.ant_pat* file.

To import a **.csv* file ensure the file has the **.csv* extension. Start the antenna pattern gain editor and select **File-CSV Import…** Use the **Import CSV** dialog to navigate to the file you want to use. Select the file then click **Open** Select **File-CSV Export…**to export an **.ant_pat* file in the **.csv* format. Use the **Export CSV** dialog to navigate to the folder where you want to store the **.csv* file. Type a filename in the **File name** text box and click **Save**.


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The format of a comma-separated variable file for antenna pattern data:

Line 1 contains one blank field then azimuth cell values from -180 degrees to +180 degrees. The default resolution is 5.00 degrees with cells centred at -177.50, -172.50,…. degrees and so on.

For the remaining lines, column 1 contains elevation cell values from 90 to -90 degrees, for 5 degree resolution, these values will be 87.50, 82.50…degrees and so on.

The remaining columns contain the attenuation values for each cell in dB, range: -20.0 to +99.9 dB, with a resolution of 0.01 dB.

The following listing shows the top left-hand corner of an example **.csv* antenna pattern file using 5 degree resolution (with tabs added for readability).

```
,-177.50,  -172.50,  -167.50,  -162.50,  -157.50,  -152.50,  -147.50,..
 87.50,  0,    0,    0,    0,    0,    0,...
 82.50,    0,    0,    0,    0,    0,    0,...
 77.50,    0,    0,    0,    0,    0,    0,...
 72.50,    0,    0,    0,    0,    0,    0,...
 67.50,    0,    0,    0,    0,    0,    0,...
 ...
 ...
```

## 23.2.2 Receiver antenna phase pattern

***Note**: See **Azimuth resolution and Elevation resolution** (page 23-13) if you use an interval less than the default 5 degrees or **High Rotation Rate***

SimGEN uses the receiver antenna phase pattern to alter the simulated carrier phase from each satellite signal according to its angle of incidence on the receiver antenna. The antenna phase pattern file (**.pha*) represents the carrier phase response of the antenna when mounted on the vehicle and should include effects such as body and wing tip distortions.

The antenna phase pattern file contains phase values of the receiver antenna at the discrete angular intervals and range in azimuth and elevation shown in this table:

| Parameter | Range |
|---|---|
| Azimuth interval | 5° (default), 4°, 3°, 2°, 1° |
| Azimuth range | -180° to +180°, in steps of the Azimuth interval |
| Elevation interval | 5° (default), 4°, 3°, 2°, 1° |
| Elevation range | -90° to +90°, in steps of the Elevation interval |
| Phase range | -180° to +180° |

With GSS7xxx and GSS8000-series signal generators, by default SimGEN downloads the antenna phase pattern to the signal generator for further processing.

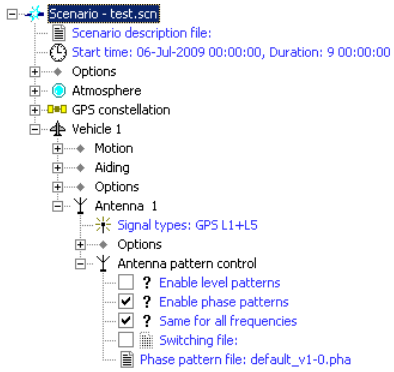
SimGEN directly calculates all phase pattern effects for the GSS6700 (and the superseded GSS6560) signal generator.

### 23.2.2.1 Antenna phase pattern editor

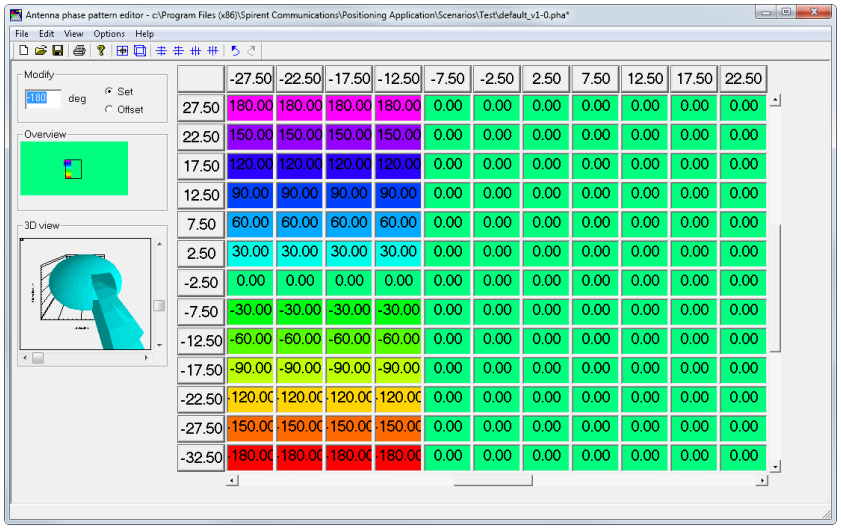
Edit, or define and then save your antenna phase pattern file in the same way as for the antenna level pattern file see ***Antenna level pattern file*** (page 23-10). Spirent recommends you normalise the antenna phase pattern file to refer the normal phase pattern of the antenna to 0.0°.

To enable antenna phase patterns select **<constellation>-Antenna *n*-Antenna pattern control-Enable phase patterns**, see the figure below. If your scenario uses two or more frequencies, you will see **Same for all frequencies**. To use a single phase pattern for all frequencies from this constellation (for example, GPS L1 and L5) select **Same for all frequencies**.


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The following figure shows the **Antenna phase pattern editor**, which shows steps in phase of ±30 degrees about zero, up to the limit of ±180 degrees.




Use the **Antenna phase pattern editor** in the same way as the **Antenna level pattern editor** however, you can use negative and positive phase. This table shows the definitions of carrier phase shift Spirent uses in the **Antenna phase pattern editor**.

| Phase shift | Result | Equivalent effect |
|---|---|---|
| Positive | Retards carrier phase | Receiver moves away from satellite |
| Negative | Advances carrier phase | Receiver moves closer to satellite |

### 23.2.2.2 Wrap-up and phase discontinuities

***Note**: It is particularly important that changes in phase value from cell to cell should generally reduce in magnitude as the cells get closer to the elevation poles.*

If the difference between antenna phase pattern data in adjacent azimuth (or elevation) cells is 180° or more, then (simulated) phase wrap-up occurs. For example, if one cell had a value of +175° and the next was -175°, then the simulated change between them would be +10° (from +175° to +185°).

Therefore, if an antenna exhibits true phase discontinuities of 180° or more, you must enter this data into the antenna pattern as two or more steps of less than 180°. If this is not desirable, it is possible to scale the entire pattern (up to a range of ±1 800°) by sending a special code to the signal generator. Contact Spirent Global Services for engineering assistance to do this.

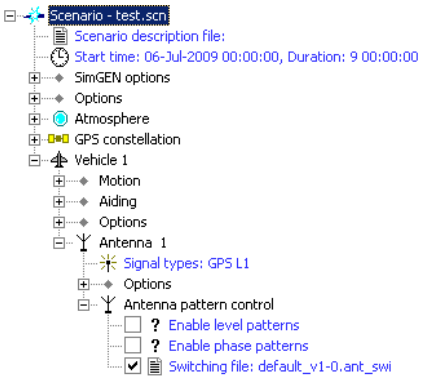
If an antenna exhibits both wrap-up and phase discontinuities, contact Spirent Global Services for engineering assistance.

If an antenna exhibits wrap-up, or has a total phase range exceeding ±90°, there are special considerations for high rotation rates, since there is a trade-off between maximum rotation-rate and maximum antenna pattern value step. Contact Spirent Global Services for engineering assistance to assure the validity of your simulation.


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## 23.2.3 Switching receiver antenna pattern and offset

You can change the receiver antenna level pattern and the receiver antenna offset from the vehicle's Centre of Gravity (CofG) throughout the scenario using pre-determined, timed sequences that you create using the switching file ***List Editor***, and then store in a switching file. This figure shows the default **Switching file** name *default_vx-yy.ant_swi*.



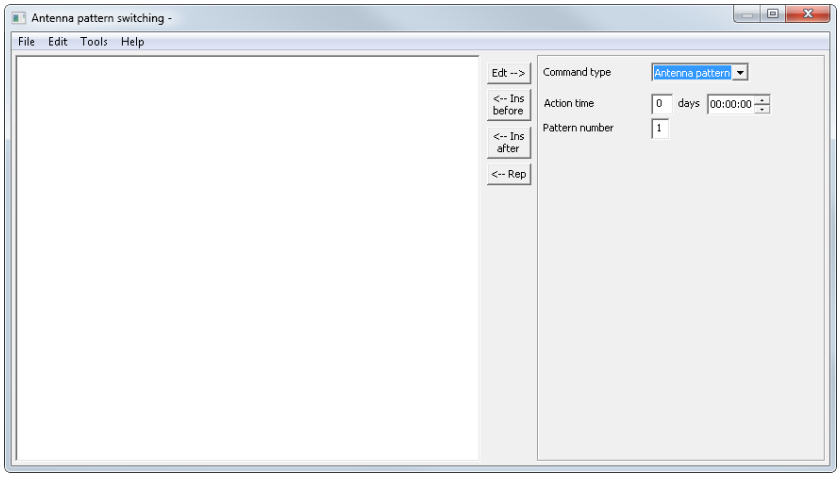

### 23.2.3.1 Switching receiver antenna level pattern

***Notes**:*

***1)** Switching the antenna level pattern does not affect antenna position or orientation.*

***2)** SimGEN automatically saves these List Editor actions in a time-ordered list.*

Use the SimGEN ***List Editor*** (page 5-33) to switch up to four different receiver antenna level patterns within a scenario. This figure shows the **Antenna pattern switching-antenna pattern** dialog:




To switch to a new receiver antenna pattern:

→ Select **Switching file:**

→ Click **New** or **Edit**

→ Select **Command type-Antenna pattern**

→ In the **Action time days** text box type the number of days into the scenario at which you want the pattern to change

→ Now enter the time of day at which you want the pattern to change in the **hh:mm:ss** text box. For each of the hours, minutes or seconds of the time of day, type the time or select the time using the Up / Down arrows

→ Type the antenna level pattern number (value 1 to 4) in **Pattern number:**
The antenna level pattern number specifies the antenna pattern file to use. The antenna pattern file numbers correspond to the antenna level pattern files listed in **Scenario-Vehicle-Antenna-Antenna pattern control**, see ***Switching receiver antenna level pattern*** (page 23-18)

→ The switching file only contains the data visible in the left-hand area


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→ Save the antenna switching file by clicking **File-Save**. For a new switching file, click **File-Save As** and enter a name for the switching file. This filename will appear next to **Switching file:**

You can edit an existing switching file by selecting the filename in **Antenna pattern control-switching file:** and clicking **Edit**.

### 23.2.3.2 Switching receiver antenna offset

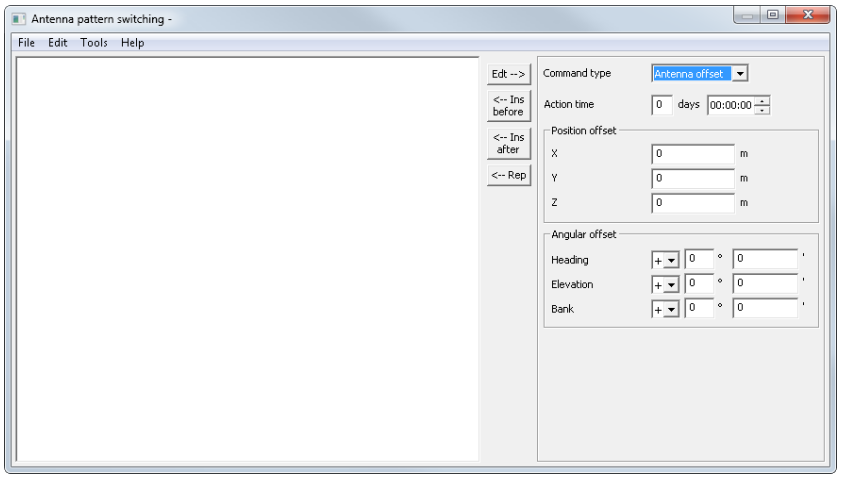
***Notes**:*

***1)** SimGEN automatically saves the actions in a time-ordered list*

***2)** The **antenna offset** settings override any settings in the **Offsets file** (page 23-6)*

***3)** The settings in **antenna offset** apply to all antenna patterns. If you set an **antenna offset** and then change **antenna pattern,** the **antenna offset** applies to the new **antenna pattern***

Use this Command Type to change receiver antenna position (with respect to the vehicle CofG) or antenna level pattern orientation during a scenario, but see Note 2) above. This figure shows the **Antenna pattern switching-antenna offset** dialog:




To switch receiver antenna offset:

→ Select **Antenna pattern control-Switching file:**

→ Click **New** or **Edit**

→ Select **Command type-Antenna offset**

→ Type the number of days into the scenario at which you want the offset to change in the **Action time days** text box

→ Now enter the time of day at which you want the offset to change in the hh:mm:ss text box. For each of the hours, minutes or seconds of the time of day, type the time or select the time using the Up / Down arrows

→ Type the X, Y and Z values for the antenna offset you want to use in **Position offset**, see parameters below

→ Type the **Heading**, **Elevation** and **Bank** values (in degrees and minutes) for the angular offset you want to apply to the antenna level pattern in **Angular offset**, see parameters below

→ The switching file only contains the data visible in the left-hand area

→ Save the antenna switching file by clicking **File-Save**. For a new switching file, click **File-Save As** and enter a name for the switching file. This filename will appear next to **Switching file:**

| | | | |
|---|---|---|---|
| **Position offset** | Offsets the antenna pattern from the vehicle's Centre of gravity (CofG) | | |
| **X, Y, Z** | Units: metres | Range: ± 500 m | Default: 0 |
| **Angular offset** | Rotates the antenna pattern | | |


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| | | | |
|---|---|---|---|
| **Heading**<br>**Elevation**<br>**Bank** | Units: degrees, minutes | Range: ± 180° | Default: 0 |

You can edit an existing switching file by selecting the filename in **Antenna pattern control-switching file:** and clicking **Edit**.

## 23.3 Transmitter antenna level and phase patterns

***Notes**:*

***1)** The default antenna pattern file for transmitter antennas (default_vx-yy.ant_pat) approximates the pattern in use by real-world satellites*

***2)** The boresight direction of the default antenna level pattern file corresponds to 90° elevation*

***3)** Transmitter antenna phase patterns are available on the GSS9000-series and GSS7000 signal generators*

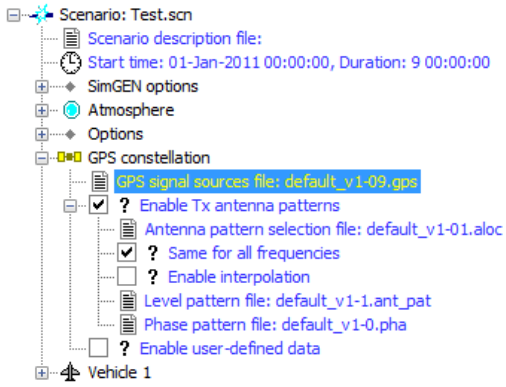
A real-world GNSS satellite uses one transmitter (Tx) antenna for each supported frequency. From SimGEN version 3-00 onwards, you can use a different transmitter antenna level pattern for each supported frequency, for each satellite, in each constellation. For example, if your scenario uses 32, L1-only, GPS satellites, you can configure up to 32 different transmitter antenna level patterns, one for each satellite in the constellation.

SimGEN version 3-00 onwards treats ***Ground Transmitter (embedded interferer)*** (page 19-1) as a separate constellation and lets you create and use separate Ground Transmitter antenna level patterns for each antenna in use.

SimGEN version 5.04SR01 onwards lets you apply phase patterns for each transmitter antenna in use when using GSS9000-series signal generators.

PosApp 6-00 onwards supports phase patterns for each transmitter antenna in use when using the GSS7000 signal generator.

You change the transmitter antenna level and phase patterns from within the constellation. This figure shows the GPS constellation file editor:



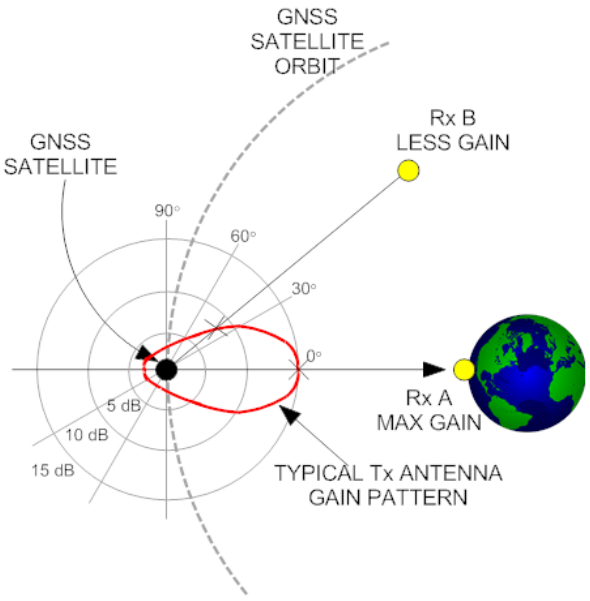

### 23.3.1 Transmitter antenna level patterns

The transmitter antenna level pattern file (**.ant_pat*) allows SimGEN to simulate the variation of power level as a vehicle moves away from the normal terrestrial condition, where it lies on (or close to) the boresight of the transmitting antenna on the satellite. This is a significant effect for orbiting space vehicles.

Spirent assumes the boresight of the transmitter antenna points to the centre of the Earth. Typically, a GNSS satellite transmitter antenna has minimum loss in the direction of the centre of the Earth, see the figure below, and the transmitter antenna level pattern modifies the signal level in the satellite to receiver path.



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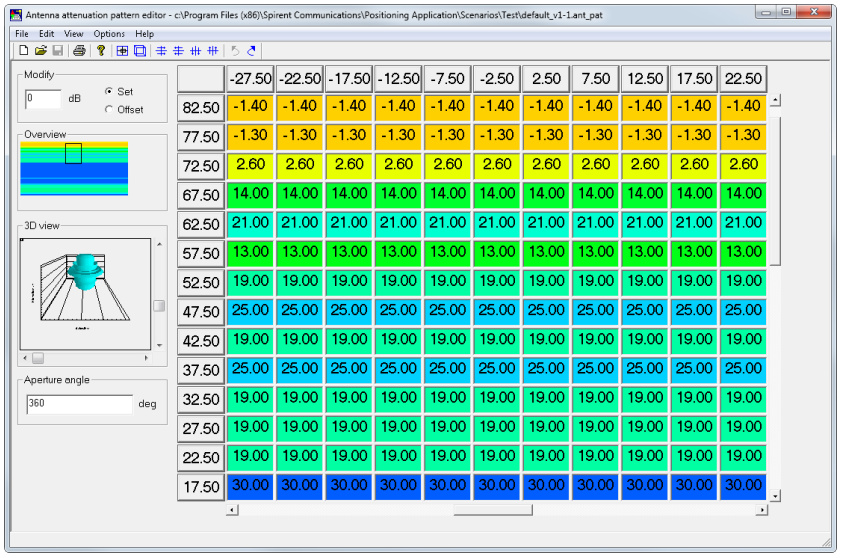



For each transmitter antenna on each satellite, you can:

- Automatically use a single default antenna level pattern for all transmitter antennas (the default); or
- Create and apply separate antenna level patterns for each transmitter antenna (up to a maximum of 63 separate antenna level patterns and 63 separate antenna phase patterns)

Transmitter antenna level and phase patterns use the same file formats and extensions as receiver antenna level patterns, **.ant_pat*, and receiver antenna phase patterns **.ant_pha*. You create, edit, import and export transmitter antenna patterns in the same way as receiver antenna patterns, see ***Antenna pattern*** (page 23-9).

By default, SimGEN uses the same antenna pattern (*default_vx-yy.ant_pat*) for each transmitting antenna in each satellite in each constellation in your scenario. The default file Spirent supplies is an example (non-isotropic) transmitter antenna level pattern file. The following figure shows this file in the antenna pattern editor:



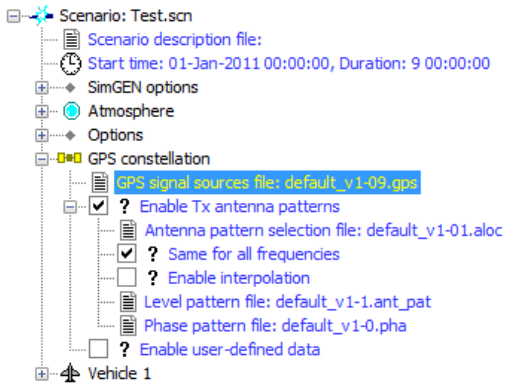

When SimGEN applies a transmitter antenna level pattern, it first determines the azimuth and elevation angles for the line-of-sight path from the satellite to the receiver. SimGEN uses these angles to identify the applicable cell in the transmitter antenna level pattern file and uses the level (gain or attenuation) assigned to that cell.

## 23.3.2 Transmitter antenna level and phase patterns

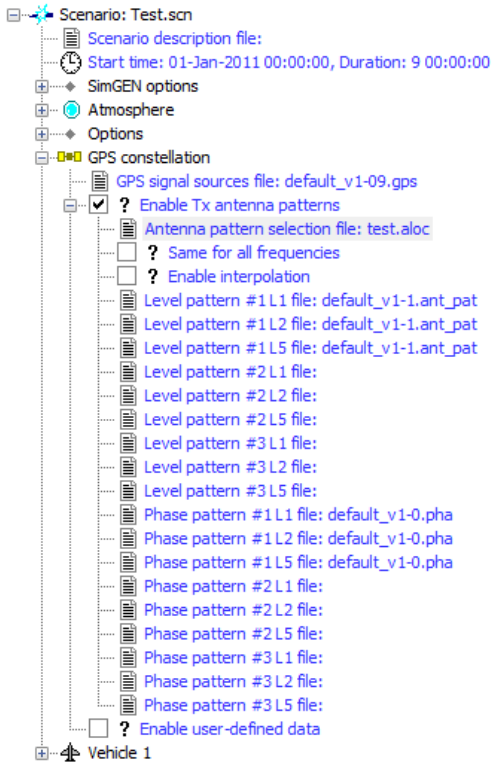
***Note**: Where **Frequency band no** is not present in a constellation, SimGEN ignores any **Pattern number** you assign to that **Frequency band no***


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To enable Transmitter antenna level patterns select **<constellation>-Enable Tx antenna patterns**, see the figure below. If your scenario uses two or more frequencies, you will see **Same for all frequencies**. To use a single Transmitter antenna level and phase pattern for all frequencies from this constellation in your scenario (for example, GPS L1, L2 and L5) select **Same for all frequencies**.




This figure shows an example of **Same for all frequencies** deselected when using three patterns for antenna level and phase, for GPS L1, L2 and L5. Here there are three level and phase patterns for each of L1, L2 and L5, in this case the level and phase patterns **#2** and **#3** have yet to be created:




Double-clicking on a **Level pattern** file opens this file in the antenna level pattern editor; double-clicking a **Phase pattern file** opens this file in the antenna phase pattern editor. Where there is no file name, such as **Level pattern #2 L1 file**, or **Phase pattern #2 L1 file**, in the figure above, the editor opens the default file.

Edit a transmitter antenna level pattern in the same way as you edit receiver antenna level patterns, see ***Receiver antenna level pattern*** (page 23-9). Edit the transmitter antenna level pattern to reflect the pattern you want to use. Spirent recommends you always save a new antenna level pattern file to a unique filename of your choice, rather than over-writing the default antenna level pattern file.

Edit a transmitter antenna phase pattern file in the same way as for the receiver antenna phase pattern file see ***Receiver antenna phase pattern*** (page 23-16). Spirent recommends you normalise the antenna phase pattern file to refer the normal phase pattern of the antenna to 0.0°.

Selecting **Enable Tx antenna patterns-Enable interpolation** lets SimGEN interpolate between cell values in the level pattern file to avoid step changes at cell boundaries.


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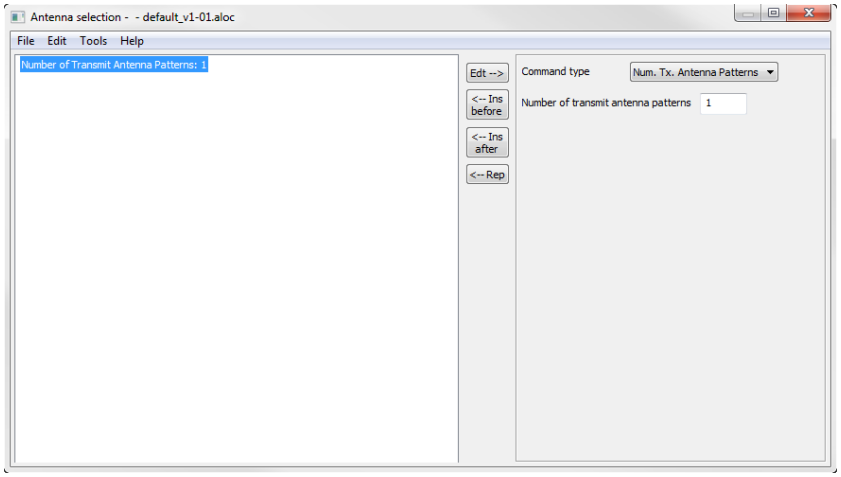
### 23.3.2.1 Using more than one Transmitter antenna level and phase patterns

***Notes**:*

***1)** Changing the transmitter antenna level pattern does not affect antenna position or orientation.*

***2)** SimGEN automatically saves List Editor actions in a time-ordered list.*

Use the SimGEN ***List Editor*** (page 5-33) to switch up to 63 transmitter antenna level and phase patterns in a scenario. This figure shows the **Antenna pattern selection** dialog:




First you must set the number of transmitter antenna level and phase patterns you want to use:

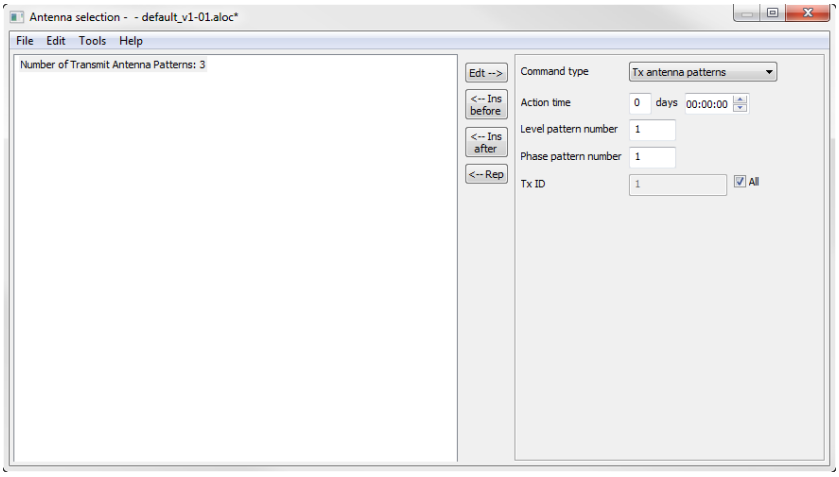
→ Double-click **<constellation>-Enable Tx antenna patterns-Antenna pattern selection file.** This opens the SimGEN List Editor that will generate the antenna selection file **.aloc*.

→ Select **Command type-Num. Tx. Antenna pattern**

→ In the **Number of transmit antenna patterns** text box, type the number of antenna level and phase patterns you want to use. The number of phase patterns is always equal to the number of level patterns.
Notice this is a single command and you can only **Edit** or **Replace** the existing command.

Now set when you want to use each pattern:

→ Select **Command type-Tx antenna patterns**

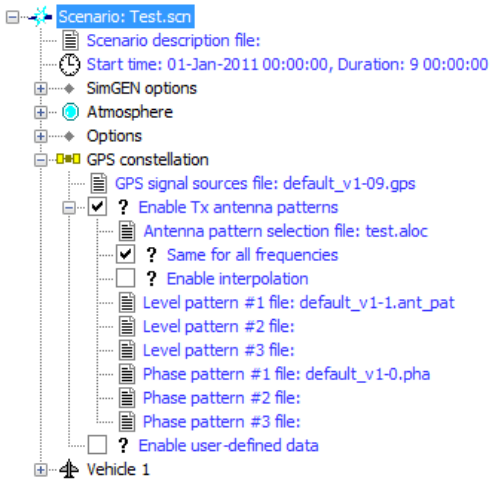



→ In the **Action time days** text box type the number of days into the scenario at which you want the pattern to change

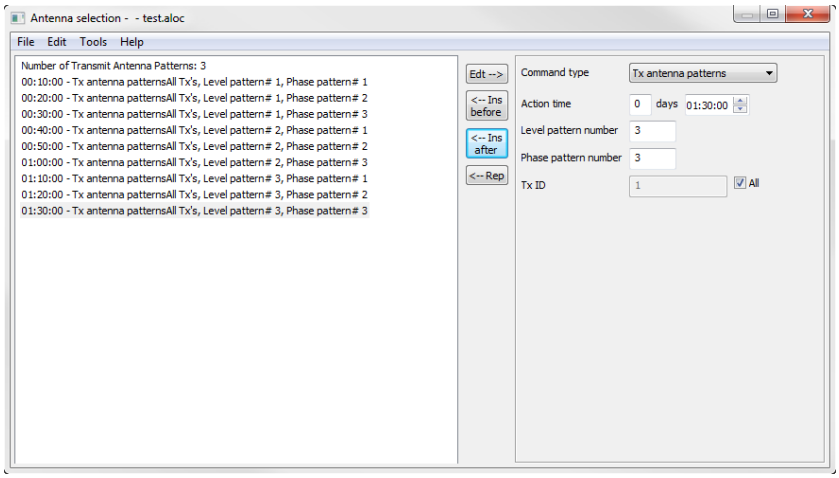
→ Now enter the time of day at which you want the pattern to change in the **hh:mm:ss** text box. For each of the hours, minutes or seconds of the time of day, type the time or select the time using the Up / Down arrows


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→ Type the transmitter antenna level pattern number in **Level pattern number**.
**Level pattern number** specifies the number of the antenna pattern file to use; for example, **#1**, **#2** or **#3** in the following figure (you cannot exceed the number of patterns you previously defined in **Num. Tx. Antenna pattern**):




→ Now enter the **Phase pattern number** in the same way.
This figure shows three level pattern files and three phase pattern files, each changing at 10 minute intervals:




→ Now use **Tx ID** to set the satellites in the constellation to use these level and phase files.
By default, **Tx ID** is set to **All**, which sets all satellites in the constellation to use the Transmit antenna level and phase patterns you previously defined.
To use a subset of the satellites in a constellation, deselect **All** and enter the **Tx ID** of each satellite to which you want to apply the antenna level and phase patterns.
Enter the **Tx ID** in the same way as you would enter a Windows print range, for example:
A single integer: **10**
A range: **5-10**
A stepped range: **10-30/5** which is identical to 10,15,20,25,30
A split range: **1-3,5,7-9** which is identical to 1,2,3,5,7,8,9

***Note**: If you enter a range in **Tx ID** and then select **All**, the range you entered remains in the (now disabled) **Tx ID** area and is over-ridden by selecting **All***

→ Save the **Antenna selection** file by clicking **File-Save**.
To create a new **Antenna selection** file, click **File-Save As** and enter a name for the file. This filename will appear next to **Antenna pattern selection file:**

→ The **Antenna selection** (**.aloc)* file only contains the data visible in the left-hand area

You can edit an existing **Antenna selection** file by selecting the filename in **<constellation>-enable Tx antenna patterns-Antenna pattern selection file:** right-clicking and selecting **Edit**.


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# 24 Channel assignment and multipath types

***Note**: SimGEN cannot start more than twelve multipaths (regardless of type) at the same time.*

Normally, SimGEN automatically assigns satellites to signal generator channels. For each vehicle and antenna, however, you can specify a channel using ***Channel assignment*** (page 24-1) to assign a signal to the channel you want to use. You can also use SimGEN to:

- Define multipath signals (or echoes) you want to using ***Manual multipath settings*** (page24-2), assigning the multipath signals to channels you specify.
- Apply ***Pseudorange ramps*** (page 24-21)
- Depending on your signal generator, you can use ***Embedded multipath*** (page 24-17) to allocate up to four sub-channels for multipath signals

To apply your channel assignment or multipath either:

- Record your action of applying the channel or multipath during a running scenario by using the menu item **Options-**(***User Actions Recording*** (page 5-30). You can apply this file during subsequent scenarios;, which will apply the same user action at the same time you made the original user action; or
- Before running the scenario, create a user action file using the SimGEN ***List Editor*** (page 5-33) then save the scenario with this user action file.
  You must select and enable the user action file before you run the scenario.

## 24.1 Channel assignment

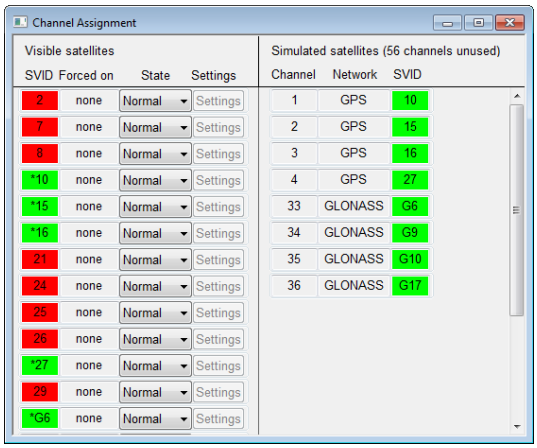
***Notes:***

***1)** SimGEN does not simulate all visible satellites, there could be more satellites than channels, or some satellites could be set as banned.*

***2) Network** is only visible if your scenario uses more than one type of constellation, excluding SBAS. The following figure shows both GPS and Galileo constellations.*

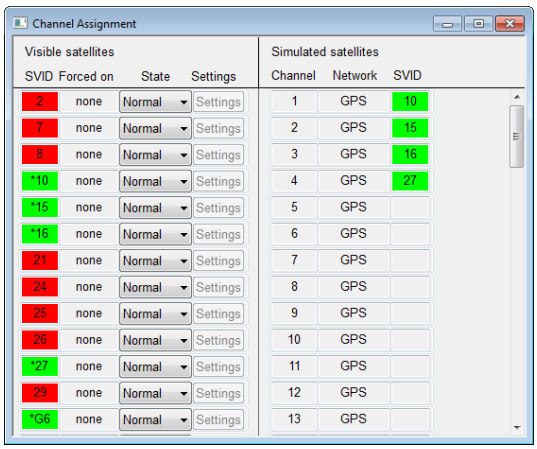
To display the **Channel Assignment** dialog, either click on the **Channel Assignment** button on the scenario toolbar (after selecting the icon set for the required vehicle and antenna); or, in the Scenario Control window, right-click on the appropriate antenna and select **Channel Assignment** window.

When you deselect **Options-*Control Options*-Channel centric view** (page 5-13), the **Channel Assignment** dialog shows the number of unused channels in the title of the right-hand side area:




When you select **Options-*Control Options*-Channel centric view**, the **Channel Assignment** dialog does not refer to channels:


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The left-hand side of the dialog shows the satellite **SVID** and the signal **State**. This table shows **States** for all visible satellites.

| State | Description |
|---|---|
| **Normal** | SimGEN automatically assigns the satellite to a channel |
| **Forced** | SimGEN forces the satellite onto a channel you specify<br>The **Forced on** column shows the channel. It will not change while the satellite remains visible<br>Click **Settings** to change the channel |
| **Banned** | Removes an SVID from your scenario<br>Select **Banned** for the SVID you want to remove |
| **Multipath** | Use ***Manual multipath settings*** (page 24-2) and select a multipath model to apply and the channel you want the multipath signal to use<br>Click **Settings** to change the multipath parameters |
| ***Note**: These multipath models and the method of allocation are different from those in the specialised **Land mobile multipath** (page 21-58) model* | |
| **Include** | Assigns the satellite to any available channel |
| **Settings** | Use to change parameters for State-Forced and State-Multipath. |

The right-hand side of the dialog shows the physical **Channel**, the **Network** and satellite **SVID** assigned to that channel, for all simulated satellites.

## 24.2 Manual multipath settings

***Notes**:*

***1)** SimGEN sets the multipath signal OFF in the one second (typically 0.6 seconds) before the off time you specify. This ensures sufficient time to load new data to the signal generator channel.*

***2)** You must select **Vehicle-Options-Vertical plane file** to see **Vertical plane**.*

***3)** You must select **Vehicle-Antenna-Options-Enable reflection pattern multipath** to see **Reflection pattern multipath**.*

The **Manual multipath settings** dialog displays when you select **Channel Assignment-State-Multipath**. This table details the multipath types you can access from the **Manual multipath settings** dialog (and see Notes above) together with other multipaths available in SimGEN.

| Multipath |
|---|
| **Manual multipath settings** |
| ***Ground reflection*** (page 24-3) |
| ***Fixed offset*** (page 24-5) |



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| Multipath |
|---|
| ***Doppler offset*** (page 24-5) |
| ***Legendre*** (page 24-7) |
| ***Polynomial*** (page 24-8) |
| ***Sinusoidal*** (page 24-10) |
| **Vehicle-options** |
| ***Vertical plane*** (page 24-12) |
| ***Land mobile multipath*** (page 21-58) |
| **Antenna-Options** |
| ***Reflection pattern multipath*** (page 24-15) |
| **User Actions file** |
| ***Embedded multipath*** (page 24-17) |

### 24.2.1 Ground reflection

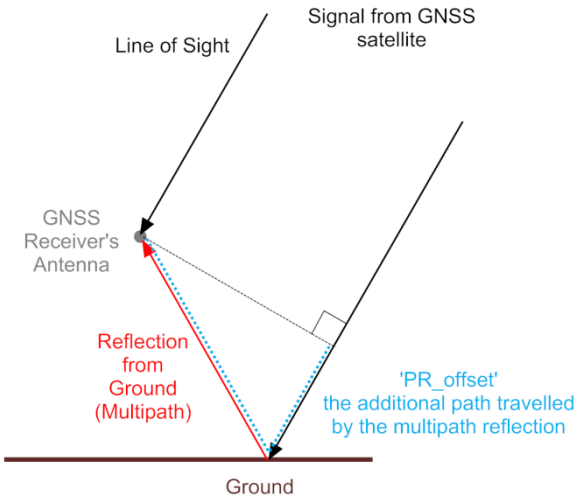
***Notes***:

***1)*** *SimGEN sets the multipath signal OFF in the one second (typically 0.6 seconds) before the off time you specify. This ensures sufficient time to load new data to the signal generator channel.*

***2)*** *The receiver's antenna level pattern modifies the final simulated power level. As an example, suppose SV 1 was at high elevation and the antenna level pattern had 0 dB loss to signals from above, and 30 dB loss to signals from below. The actual difference between LoS and reflected signals is 3.5 + 30 = 33.5 dB - this is lower than the LoS signal.*

This model assumes a flat plane Earth surface below the vehicle (at the WGS-84 ellipsoid height) and calculates the range and arrival angle (at the antenna) of the satellite signal reflection from this plane.

The figure below shows two signal paths from a GNSS satellite: the line of sight path, and a ground reflection, to the antenna of a GNSS receiver. The ground reflection (the multipath signal) results in a slightly longer path length that has a slightly higher attenuation.




SimGEN uses separate attenuation for the Line of Sight (LoS) and each multipath signal, which you specify.

SimGEN can optionally calculate the extra attenuation due to the additional path length of the multipath. In this case, SimGEN first calculates the signal level from the satellite at the ground, $P_{ground}$, in the same way as it calculates the power of line of sight signals. SimGEN then treats this signal as if it was transmitted from the ground to the antenna of the GNSS receiver, and calculates the loss, $P_{loss}$, in dB from the ground to the vehicle, using:


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$$P_{loss} = 20.0 \times \log_{10}\left(\frac{4 \times \pi \times range_{ground_to_antenna}}{wavelength}\right)$$

SimGEN then calculates the power of the multipath signal, $P_{mp}$, received at the antenna using:

$$P_{mp} = P_{ground} - P_{loss}$$

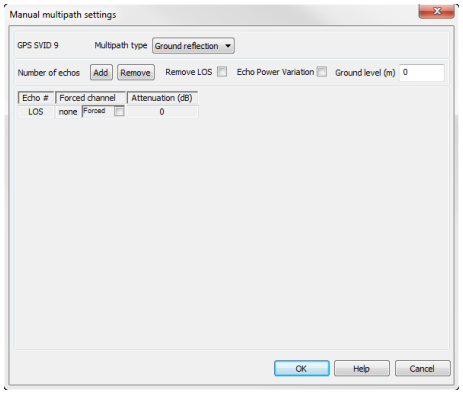
In this context:

1) Spirent assumes there is no power loss when the ground to antenna distance is closer than the far-field limit (that is, closer than 10 times the signal wavelength, which equates to 1.9 metres for GPS L1)

2) SimGEN calculates the power loss for the first frequency of a signal and applies this loss for all signal frequencies

3) The power loss is sharp – approximately 50 dB. at 5 metres rising to 76 dB at 100 metres. If necessary, you can compensate for this attenuation by applying a positive value for the **Echo #-Attenuation**.

The figure below shows the **Manual multipath settings-Multipath type-Ground reflection** dialog.




| | | | |
|---|---|---|---|
| **Add** | Add a **Ground reflection** multipath signal to the LoS.<br>Range 0 to 16. | | |
| **Remove** | Removes the selected **Ground reflection** from the simulation | | |
| **Remove LoS** | Deselect (default): includes LoS in simulation<br>Select: removes LoS from the simulation | | |
| **Echo Power Variation** | Deselect (default): Echo power does not vary with height of vehicle<br>Select: Echo power varies with height of vehicle, as described above | | |
| **Ground level (m)** | Set the ground level on which the vehicle sits to be above or below the WGS-84 ellipsoid height | | |
| | Units: metres | Range: -1 000 to 10 000 m | Default: 0 |
| **Echo #** | SimGEN assigns an Echo number (**Echo #**) to each multipath signal.<br>Range 1 to 16.<br>SimGEN adds the new signal to the bottom of the table in the dialog. | | |
| **Forced Channel** for each Echo | Deselect (default): SimGEN allocates multipath signal to any available channel<br>Select: force the multipath signal to a channel you specify.<br>If you do not specify a channel, the next available channel is used. | | |
| **Attenuation (dB)** for each Echo | Type the difference in level between the main signal and the reflected signal.<br>In the figure above, the reflected signal (Echo 1) will be attenuated 3.5 dB from the original (LoS) signal | | |
| | Units: decibel | Range: -20 to 40 dB | Default: 0 |



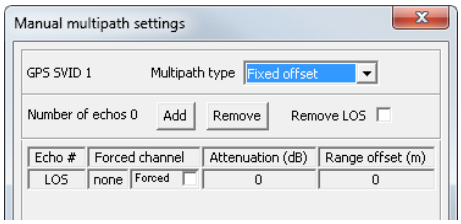
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### 24.2.2 Fixed offset

***Note**: SimGEN sets the multipath signal OFF in the one second (typically 0.6 seconds) before the off time you specify. This ensures sufficient time to load new data to the signal generator channel.*

This model creates a simple multipath signal having constant user-specified range and power offsets with respect to the normal (LoS) signal.

The figure below shows the **Manual multipath settings-Multipath type-Fixed offset** dialog.




| | | | |
|---|---|---|---|
| **Add** | Click to add a **Fixed offset** multipath signal. Range 0 to 16. | | |
| **Remove** | Removes the selected **Fixed offset** from the simulation | | |
| **Remove LOS** | Deselect (default): includes LoS in simulation<br>Select: removes LoS from the simulation | | |
| **Echo number** | SimGEN assigns an **Echo number** to each multipath signal.<br>Range 1 to 16.<br>SimGEN adds the new signal to the bottom of the table in the dialog. | | |
| **Forced Channel** (for each Echo) | Deselect (default): SimGEN allocates multipath signal to any available channel<br>Select: force the multipath signal to a channel you specify.<br>If you do not specify a channel, the next available channel is used. | | |
| **Attenuation (dB)** (for each Echo) | Between the LoS signal and the relevant echo. | | |
| | Units: decibel | Range: -20 to 40 dB | Default: 0 |
| ***Note**: The receiver's antenna level pattern modifies the final simulated power level by the same amount for both the LoS and multipath signals, so the difference will always be as you specify* | | | |
| **Range offset (m)** | The simulated pseudorange difference between the LoS and the multipath signals<br>***Note**: A positive value for **Range offset** means the multipath pseudorange is GREATER than the LoS pseudorange.* | | |
| | Units: metres | Range: 0 to 1 000 m | Default: 0 |

### 24.2.3 Doppler offset

***Notes**:*

***1)** SimGEN sets the multipath signal OFF in the one second (typically 0.6 seconds) before the off time you specify. This ensures sufficient time to load new data to the signal generator channel.*

***2)** From SimGEN version 2-52 on, you can select between **C/A chips** or **metres** as the **Initial Delay Units**. Once selected, the dialog shows correct units for the **Doppler offset**, see the following two figures*

***3)** SimGEN applies the Doppler offset (in Hz) to L1*

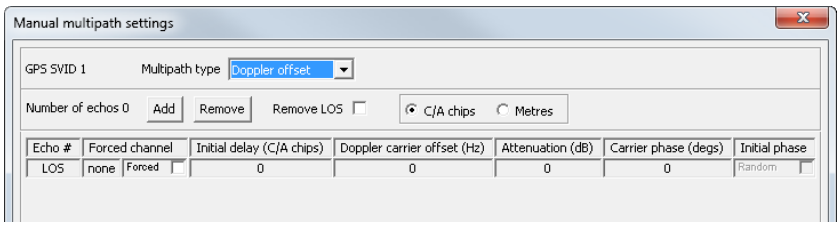
***4)** SimGEN derives the L2 Doppler offset from the L2 pseudorange rate offset. SimGEN set this to be equal to the L1 pseudorange rate offset (in m.s-1)*

***5)** See the relevant MS specification your signal generator and do not exceed its Dynamic limits*

The **Doppler offset** model meets the testing requirements of the A-GPS mobile phone test community. Full details of these tests can be found in document 3GPP TS25.171.

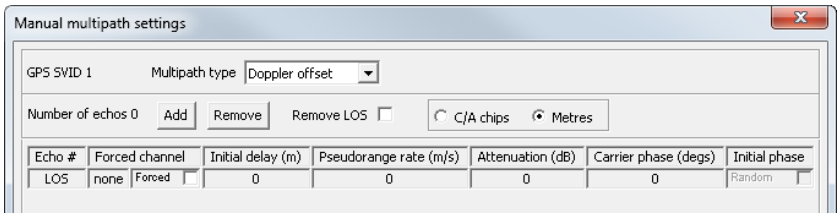
The figure below shows the default **Manual multipath settings-Multipath type-Doppler offset** dialog using **C/A chips** as the **Initial delay unit**.


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| | | | |
|---|---|---|---|
| **Add** | Click to add a **Doppler offset** multipath signal. Range 0 to 16. | | |
| **Remove** | Removes the selected **Doppler offset** from the simulation | | |
| **Remove LOS** | Deselect (default): includes LoS in simulation<br>Select: removes LoS from the simulation | | |
| **C/A chips** | (default) uses the enabled parameters in the above figure | | |
| **Echo #** | SimGEN assigns an **Echo number** to each multipath signal.<br>Range 1 to 16.<br>SimGEN adds the new signal to the bottom of the table in the dialog. | | |
| **Forced Channel** for each Echo | Deselect (default): SimGEN allocates multipath signal to any available channel<br>Select: force the multipath signal to a channel you specify.<br>If you do not specify a channel, the next available channel is used. | | |
| **Initial delay (C/A chips)** | Units: C/A chips | Range: -1 to 1 000 | Default: 0.5 |
| **Doppler offset (Hz)** | The Doppler frequency offset (applied to both code and carrier) between the LoS and the multipath echo. | | |
| | Units: Hertz | Range: ± 1 000 Hz | Default: 0.1 |
| **Attenuation (dB)** | The difference in signal level between the LoS and the multipath echo | | |
| | Units: decibel | Range: -20 to +40 dB | Default: 0 |
| **Initial phase** | Select **random** (default) to vary the initial carrier phase difference from run-to-run - **Carrier phase (degs)** shows text “randomised”.<br>Deselect **random** for a fixed initial carrier phase difference.<br>Enables **Carrier phase (degs)**. | | |
| **Carrier phase (degs)** | The carrier phase difference between the LoS and the multipath echo. | | |
| | Units: degrees | Range: ± 360° | Default: 0 |

This figure shows the dialog after selecting **Manual multipath settings-Doppler offset-Initial Delay Units-metres**.




The settings are as for **Doppler Offset** using **Initial delay unit-C/A chips**, except:

| | | | |
|---|---|---|---|
| **Initial delay (metres)** | The *initial* delay between LoS and multipath echo for the code and carrier<br>During the simulation run, the delay between the LoS and Multipath echo depends on the Doppler offset.<br>SimGEN maintains correct code to carrier Doppler ratios throughout. | | |
| | Units: metres | Range: -293.052 3 to 293 052.256 1 m | Default: 146.526 1 |


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| | | | |
|---|---|---|---|
| **Pseudorange rate (m/s)** | The Doppler frequency offset (applied to both code and carrier) between the LoS and the multipath echo, in terms of velocity. | | |
| | Units: metres per second | Range: ± 190.293 7 $m.s^{-1}$ | Default: -0.019 |
| **Attenuation (dB)** | The difference in signal level between the LoS and the multipath | | |
| | Units: decibel | Range: -20 to +40 dB | Default: 0 |

### 24.2.4 Legendre

***Notes**:*

***1)** SimGEN sets the multipath signal OFF in the one second (typically 0.6 seconds) before the off time you specify. This ensures sufficient time to load new data to the signal generator channel.*

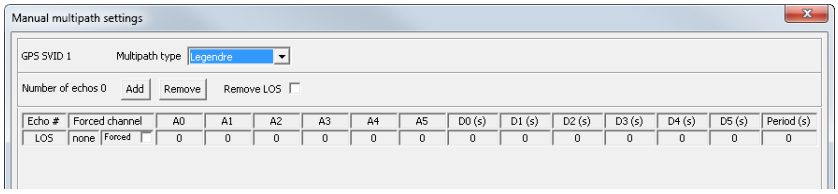
***2)** See the relevant MS specification your signal generator and do not exceed its Dynamic limits*

In the Legendre multipath model, fifth-order Legendre polynomials represent the relative amplitude and delay of the multipath signal. The Legendre model uses normalised time to give a repeatable profile, independent of duration.

This figure (page 24-12) compares the Legendre, Polynomial and Sinusoidal models. The Legendre model has the same, repeatable, profile, irrespective of duration.

Select **Multipath Type-Legendre**.

This figure shows the **Manual multipath settings-Multipath type-Legendre** dialog.




| | |
|---|---|
| **Add** | Click to add a **Legendre** multipath signal. Range 0 to 16. |
| **Remove** | Removes the selected **Legendre** multipath from the simulation |
| **Remove LOS** | Deselect (default): includes LoS in simulation<br>Select: removes LoS from the simulation |
| **C/A chips** | (default) uses the enabled parameters in this figure (page 24-6) |
| **Echo number** | SimGEN assigns an **Echo number** to each multipath signal.<br>Range 1 to 16.<br>SimGEN adds the new signal to the bottom of the table in the dialog. |
| **Forced Channel** for each Echo | Deselect (default): SimGEN allocates multipath signal to any available channel<br>Select: force the multipath signal to a channel you specify.<br>If you do not specify a channel, the next available channel is used. |

The fifth-order Legendre polynomials are:

$$R(t') = A_0P_0(t') + A_1P_1(t') + A_2P_2(t') + A_3P_3(t') + A_4P_4(t') + A_5P_5(t')$$

$$\tau(t') = D_0P_0(t') + D_1P_1(t') + D_2P_2(t') + D_3P_3(t') + D_4P_4(t') + D_5P_5(t')$$

Where:
$R(t')$ = Relative amplitude of the reflected signal (with respect to the direct signal), expressed as a ratio. Limited to the range: 0 to 1.

Alternatively, the relative amplitude in dB, $dB_{rel}$, is $-20 \times \log_{10}(RelAmp)$

and:


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$\tau(t')$ = Delay of the multipath signal relative to the direct signal (seconds), and:

$t'$ = Normalised time = $2(t - t_0)/T - 1$

$t$ = Time into simulation (seconds).

$t_0$ = Time into scenario at which to start generation of the multipath signal (seconds).

$T$ = Duration of the multipath signal (seconds).

$P_i(t')$ = Legendre polynomial of i'th order (i = 0 to 5):

$P_0(t') = 1$

$P_1(t') = t'$

$P_2(t') = 1.5t'^2 - 0.5$

$P_3(t') = 2.5t'^3 - 1.5t'$

$P_4(t') = 4.375t'^4 - 3.75t'^2 + 0.375$

$P_5(t') = 7.875t'^5 - 8.75t'^3 + 1.875t'$

The $A_i$ and $D_i$ terms are the multipath coefficients. These are in the i'th coefficients of the expansion of the relative amplitude and delay functions (respectively) in terms of Legendre polynomials, determined using the following equations, for known R(t') and T(t') profiles.

$$A_i = \frac{\int_{-1}^{1} P_i(t')R(t')dt'}{\int_{-1}^{1} P_i^2(t')dt'}$$

$$D_i = \frac{\int_{-1}^{1} P_i(t')T(t')dt'}{\int_{-1}^{1} P_i^2(t')dt'}$$

For each Legendre multipath, you must enter values for the following polynomial coefficients in the **Manual multipath settings** dialog:

| | | | |
|---|---|---|---|
| **A0 to A5** | Coefficients $A_0$ to $A_5$ in the Legendre polynomial for R(t'). | | |
| | Units: none | Range: ± 1 | Default: 0 |
| **D0(s) to D5(s)** | Coefficients $D_0$ to $D_5$ in the Legendre polynomial for D(t'). | | |
| | Units: seconds | Range: ±4 E-5 s | Default: 0 |
| **Period (s)** | The period of the Legendre cycle over which the echo is modelled.<br>Once a period expires, the echo pattern continually repeats.<br>Successive periods are mirror images of the previous period.<br><br>For example: you define the first period to be T0 → T1, then:<br>T1 → T2 is identical to T1 → T0<br>T2 → T3 is identical to T0 → T1<br>T3 → T4 is identical to T1 → T0 | | |
| | Units: seconds | Range: 0<br>to 32 400 s | Default: 0 |

### 24.2.5 Polynomial

***Notes**:*



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***1)*** *SimGEN sets the multipath signal OFF in the one second (typically 0.6 seconds) before the off time you specify. This ensures sufficient time to load new data to the signal generator channel.*

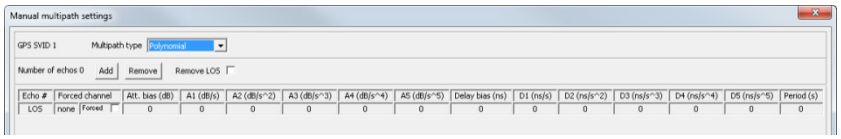
***2)*** *Do not exceed the Dynamic limits of your generator see the relevant MS specification.*

The Polynomial multipath model uses fifth-order polynomials to represent the relative amplitude and delay of the multipath signal. The polynomial model uses absolute time.

This figure (page 24-12) compares the Legendre, Polynomial and Sinusoidal models. The shape of the Polynomial model depends on time. At long times the polynomial function could rapidly move to large amplitudes, as shown by part a, or fall to small amplitudes, as shown by part b.

Select **Multipath Type-Polynomial**.

This figure shows the **Manual multipath settings-Multipath type-Polynomial offset** dialog.




| | |
|---|---|
| **Add** | Click to add a **Polynomial** multipath signal. Range 0 to 16. |
| **Remove** | Removes the selected **Polynomial** multipath from the simulation |
| **Remove LOS** | Deselect (default): includes LoS in simulation<br>Select: removes LoS from the simulation |
| **C/A chips** | (default) uses the enabled parameters in this figure (page 24-6) |
| **Echo number** | SimGEN assigns an **Echo number** to each multipath signal.<br>Range 1 to 16.<br>SimGEN adds the new signal to the bottom of the table in the dialog. |
| **Forced Channel** for each Echo | Deselect (default): SimGEN allocates multipath signal to any available channel<br>Select: force the multipath signal to a channel you specify.<br>If you do not specify a channel, the next available channel is used. |

In the Polynomial multipath model, the following functions represent the relative amplitude and delay of the multipath signal:

$$RelAmp = a_0 + a_1 t + a_2 t^2 + a_3 t^3 + a_4 t^4 + a_5 t^5$$

$$Delay = d_0 + d_1 t + d_2 t^2 + d_3 t^3 + d_4 t^4 + d_5 t^5$$

Where:

$RelAmp$ = Amplitude of the reflected signal (with respect to the direct signal), dB

$Delay$ = Delay of the multipath signal relative to the direct signal, seconds

$t$ = seconds

For each Polynomial multipath, you must enter values for the following polynomial coefficients in the **Manual multipath settings** dialog:

| | | | |
|---|---|---|---|
| **Att. bias (dB)** | Coefficient $a_0$ in the polynomial for RelAmp | | |
| | Units: decibel | Range: ±99 dB | Default: 0 |
| **A1 (dB/s) to A5 (dB/s^5)** | Coefficients $a_1$ to $a_5$ in the polynomial for RelAmp | | |
| | Units: decibel per second, to decibel per (second)$^5$ | Range: ± 1 000 | Default: 0 |
| **Delay bias (ns)** | Coefficient $d_0$ in the polynomial for Delay | | |


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| | | | |
|---|---|---|---|
| | Units: nanoseconds | Range: ±40 000 ns | Default: 0 |
| **D1 (ns/s) to D5 (ns/s^5)** | Coefficients $d_1$ to $d_5$ in the polynomial for Delay | | |
| | Units: nanoseconds per second, to nanoseconds per (second)$^5$ | Range: ±4 E-5 | Default: 0 |
| **Period (s)** | The period of the Polynomial cycle over which the echo is modelled and prevents the echo going to infinity.<br>Once a period expires, the echo pattern continually repeats.<br>Successive periods are mirror images of the previous period.<br><br>For example: you define the first period to be T0 → T1, then:<br>T1 → T2 is identical to T1 → T0<br>T2 → T3 is identical to T0 → T1<br>T3 → T4 is identical to T1 → T0 | | |
| | Units: seconds | Range: 0 to 32 400 s | Default: 0 |

## 24.2.6 Sinusoidal

***Notes**:*

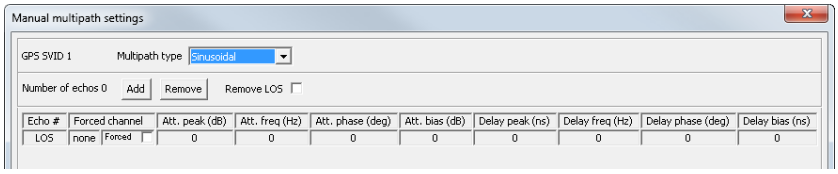
***1)** SimGEN sets the multipath signal OFF in the one second (typically 0.6 seconds) before the off time you specify. This ensures sufficient time to load new data to the signal generator channel.*

***2)** Do not exceed the Dynamic limits of your generator see the relevant MS specification.*

This model uses a simple sinusoid to represent the relative amplitude and delay of the multipath signal.

This figure (page 24-12) compares the Legendre, Polynomial and Sinusoidal models. The Sinusoidal model has a simple, cyclical dependency on time. At long times the polynomial function could rapidly move to large amplitudes, as shown by part a, or fall to small amplitudes, as shown by part b.

This figure shows the **Manual multipath settings-Multipath type-Sinusoidal** dialog.



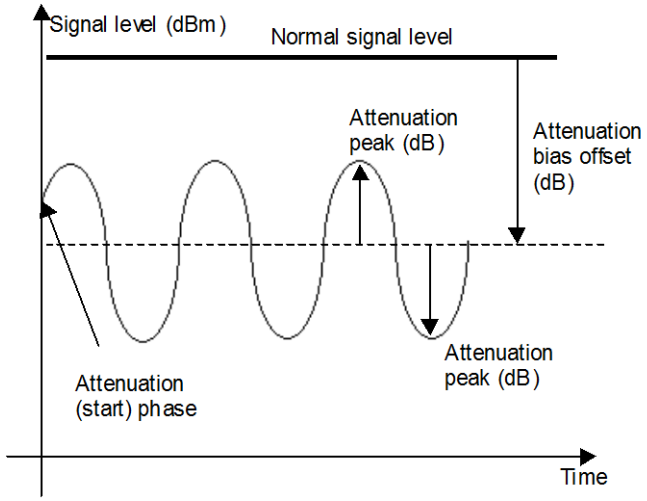

| | |
|---|---|
| **Add** | Click to add a **Polynomial** multipath signal. Range 0 to 16. |
| **Remove** | Removes the selected **Polynomial** multipath from the simulation |
| **Remove LOS** | Deselect (default): includes LoS in simulation<br>Select: removes LoS from the simulation |
| **C/A chips** | (default) uses the enabled parameters in this figure (page 24-6) |
| **Echo number** | SimGEN assigns an **Echo number** to each multipath signal.<br>Range 1 to 16.<br>SimGEN adds the new signal to the bottom of the table in the dialog. |
| **Forced Channel** for each Echo | Deselect (default): SimGEN allocates multipath signal to any available channel<br>Select: force the multipath signal to a channel you specify.<br>If you do not specify a channel, the next available channel is used. |

For each Sinusoidal multipath, you must enter values for the following sinusoidal coefficients in the **Manual multipath settings** dialog:

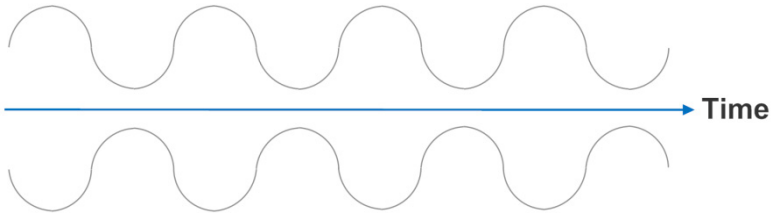
| | |
|---|---|
| **Att. Peak (dB)** | See the figure below |


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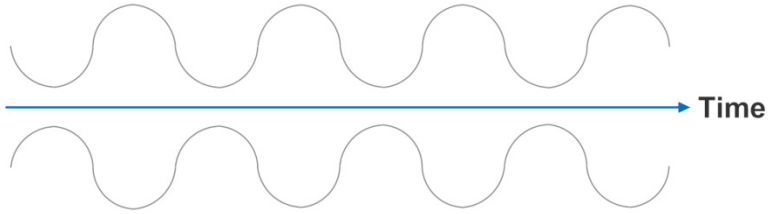
| | | | |
|---|---|---|---|
| | Units: decibel | Range: ±99 dB | Default: 0 |
| **Att freq (Hz)** | The attenuation frequency.<br>The two modulation envelope figures below show how the phase of the modulation envelope (about the frequency of the GNSS signal) changes by 180 degrees when you use positive and negative attenuation frequencies | | |
| | Units: Hertz | Range: ± 10 Hz | Default: 0 |
| **Att phase (deg)** | See the figure below | | |
| | Units: degrees | Range: ±360° | Default: 0 |
| **Att bias (dB)** | See the figure below | | |
| | Units: decibel | Range: ±99 dB | Default: 0 |




**Modulation envelope with negative attenuation frequency**



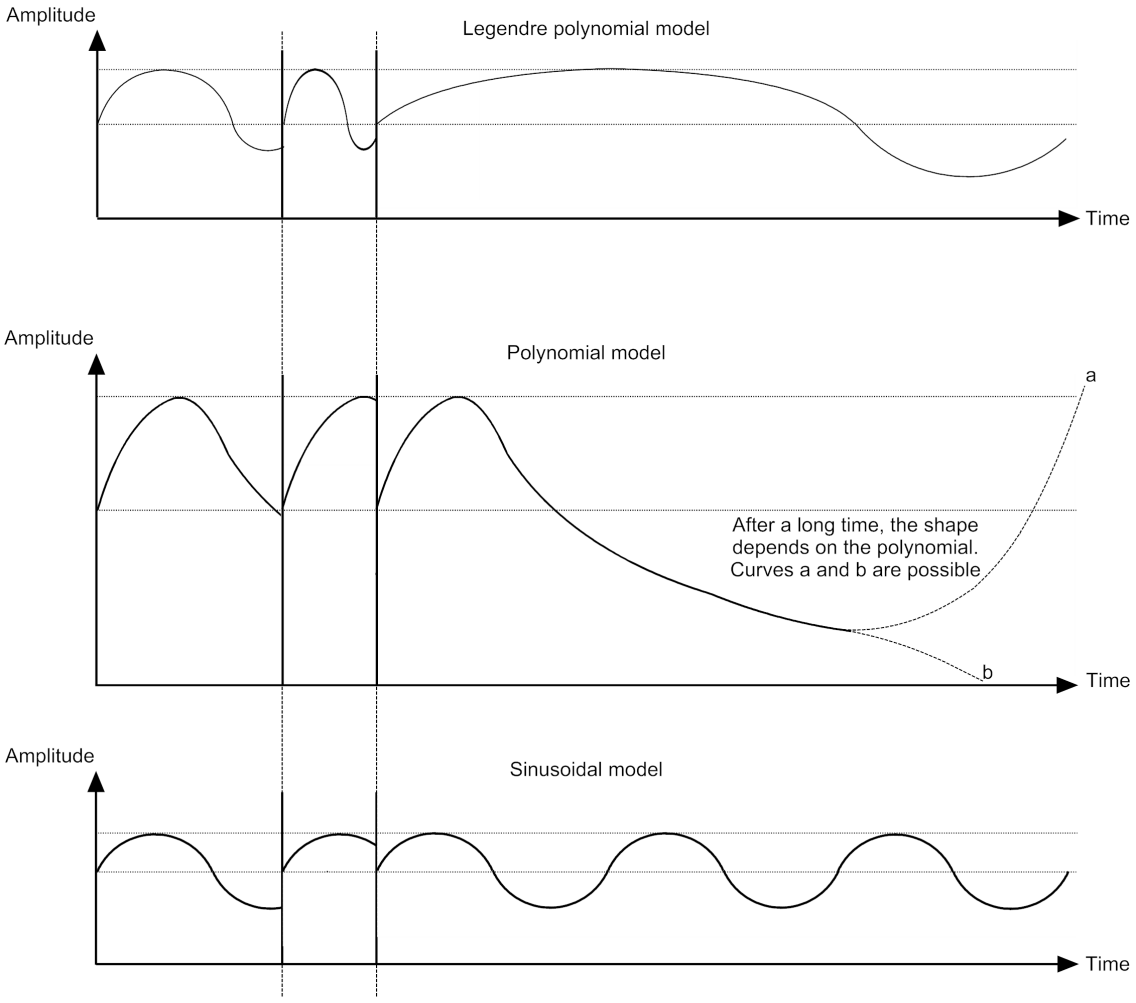

**Modulation envelope with positive attenuation frequency**




| | | | |
|---|---|---|---|
| **Delay peak (ns)** | The peak offset delay to the sinusoid | | |
| | Units: nanoseconds | Range: ±40 000 ns | Default: 0 |
| **Delay freq (Hz)** | The frequency of the offset delay to the sinusoid | | |
| | Units: Hertz | Range: ± 10 Hz | Default: 0 |
| **Delay phase (deg)** | The phase of the offset delay to the sinusoid | | |


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| | | | |
|---|---|---|---|
| | Units: degrees | Range: ±360° | Default: 0 |
| **Delay bias (ns)** | The offset delay to the sinusoid | | |
| | Units: nanoseconds | Range: ±40 000 ns | Default: 0 |




## 24.3 Vertical plane

***Notes**:*

***1)** SimGEN sets t*he multipath signal OFF in the one second (typically 0.6 seconds) before the off time you specify. This ensures sufficient time to load new data to the signal generator channel.

***2)** If you define more than one vertical plane multipath signal, the pseudorange offset and signal arrival angles will be the same in both cases, however, the other attributes can be different.*

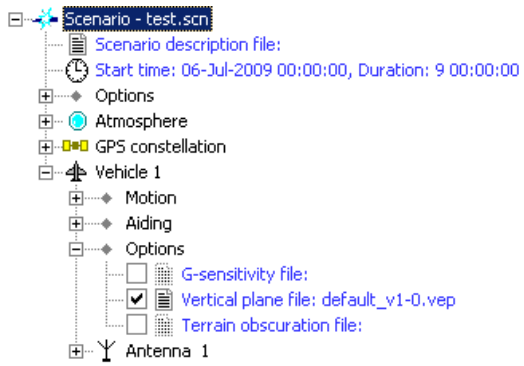
***3)** You must select multipath signals for satellites which are not only visible (in a general sense), but which are also going to have a valid reflection path. This means you can select multipath signals that could easily be inappropriate, particularly where the heading of the vehicle is significantly changing.*

The **Vertical plane** multipath model simulates satellite signal reflection from building surfaces in an urban environment as opposed to the ***Land mobile multipath*** model (page 21-58), which applies statistical signal modifications in the same context.

In the scenario window, click on **Vehicle-Options-Vertical plane file**.



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This model provides geometric representation of reflected satellite signals with respect to vertical plane surfaces placed either side of the vehicle. Both these vertical plane surfaces are:

- Of limited height
- Infinitely long
- A given distance from the vehicle
- Always parallel to the direction of vehicle motion

During the scenario, you can separately change:

- The height of the vertical plane to the vehicle
- The distance of the vertical plane to the vehicle

To use vertical plane multipath signal in a scenario, for the vehicle you want to model:

- Open the Vertical plane file editor. Select, then double-click, **Vehicle-Options-*Vertical plane file*** (page 21-41)
- Create a timed sequence of commands defining the height and distance for the reflecting surfaces
- Determine the satellites affected by these vertical planes, using ***Satellite selection and allocation*** (page 24-15)
- After creating the Vertical plane file, select the file in **Vehicle-Options**. A tick in the check box next to the file name confirms your selection, as shown in the figure above.
- Set the scenario to use this **Vertical plane file** by clicking on the **Channel Assignment** button
- Now the **Vertical plane** model is available in **State-Multipath-Multipath types**; or you can use a remote command or a User Actions file

From your timed sequence of commands, SimGEN determines the direct and multipath signals arriving at the vehicle. For the direct signal, SimGEN:

- Determines if the signal arriving at the vehicle is obscured
- If it is obscured, SimGEN sets the direct signal to a low power level

Similarly, for each multipath signal, SimGEN:

- Determines, for the relative geometry of the satellite, vehicle and reflecting surfaces, if the multipath (reflection) is possible
- If the multipath is not possible, SimGEN sets that signal to a low power level.

If a multipath is valid, SimGEN calculates the signal delay using the formula:

$2 * d * \cos(el) * \cos(az) *$ (equivalent pseudorange offset in metres)


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Where:

d: the distance to the reflecting surface (m)

el: the satellite elevation angle (with respect to the local horizontal)

az: the satellite azimuth angle (measured with respect to the normal to the reflecting surface)

SimGEN applies the following to the multipath signals:

- Fixed signal reflection loss
- Fixed or random offset in carrier phase
- Offsets the carrier Doppler, relative to the line-of-sight signal
- Amends the signal arrival angle relative to the receiver and so applies the correct antenna pattern attenuation

### 24.3.1 Vertical plane file

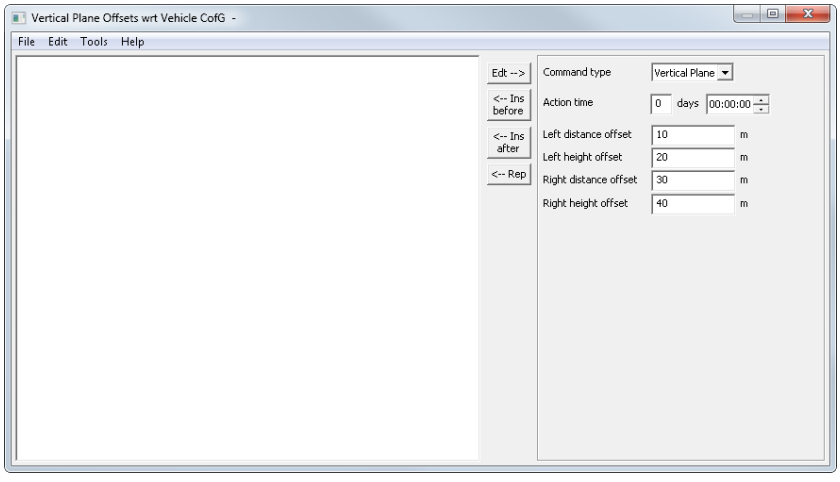
***Notes**:*

***1)** SimGEN sets the multipath signal OFF in the one second (typically 0.6 seconds) before the off time you specify. This ensures sufficient time to load new data to the signal generator channel.*

***2)** You can select the **Vertical plane** multipath model for all vehicle types. For static vehicles that also support the **Land Mobile Multipath** model, you can only use one model at a time.*

***3)** You must manually build the Command file list in the order you want. SimGEN does not automatically order these actions.*

The figure below shows the **Vertical Plane Offsets**, see *List Editor* (page 5-33). The default file is *default_1-0.vep*.



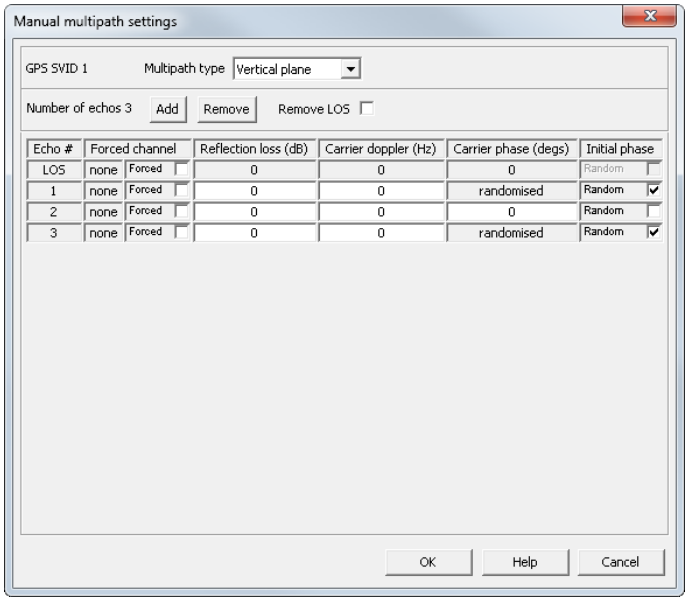

| | | | |
|---|---|---|---|
| **Action time** | Time-into-run at which the command is to be actioned | | |
| | Units:<br>d hh:mm:ss | Range: 0 00:00:00 to 23 23:59:59 | Default: 0 00:00:00 |
| **Left distance offset**,<br>**Right distance offset** | Perpendicular distance to vertical plane on left-hand and right-hand sides of vehicle | | |
| | Units: metres | Range: 0<br>to 40 000 m | Default: 10 (left)<br>30 (right) |
| **Left height offset**,<br>**Right height offset** | Height of vertical plane on left-hand and right-hand side of vehicle | | |
| | Units: metres | Range: ±40 000 m | Default: 20 (left)<br>40 (right) |



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### 24.3.2 Satellite selection and allocation

Click on the **Channel Assignment** button. In the **Visible satellites** area, find the first satellite SVID you want to use with the **Vertical plane** model. To add a multipath signal click on **State-Multipath-Vertical Plane**, then click **Add**. The figure below shows the LoS and three echoes.




Enter the values of the parameters you want to use:

| | | | |
|---|---|---|---|
| **Remove LOS** | Deselect (default): includes LoS in simulation<br>Select: removes LoS from the simulation | | |
| **Forced** | Deselect (default): SimGEN allocates multipath signal to any available channel<br>Select: force the multipath signal to a channel you specify.<br>If you do not specify a channel, the next available channel is used. | | |
| **Reflection loss (dB)** | The difference in level between the main and the reflected signals | | |
| | Units: decibel | Range: -20 to +40 dB | Default: 0 |
| **Carrier doppler (Hz)** | The frequency offset to the carrier component of the reflected signal<br>Does not affect the ranging code component | | |
| | Units: Hertz | Range: 0 to 1 E +17 Hz | Default: 0 |
| **Initial phase** | Select **random** (default) to vary the initial carrier phase difference from run-to-run - **Carrier phase (degs)** shows text “randomised”.<br>Deselect **random** for a fixed initial carrier phase difference.<br>Enables **Carrier phase (degs)** | | |
| **Carrier phase (degs)** | The carrier phase difference between the LoS and the multipath echo. | | |
| | Units: degrees | Range: ± 360° | Default: 0 |

Repeat these steps for each satellite SVID to which you want to apply vertical plane multipaths.

Based upon the satellite position, vehicle position and vertical plane definitions, the model computes the power level, arrival azimuth and elevation angles, pseudorange offset, and pseudorange-rate offset of each multipath signal.

## 24.4 Reflection pattern multipath

***Notes**:*

***1)** SimGEN sets the multipath signal OFF in the one second (typically 0.6 seconds) before the off time you specify. This ensures sufficient time to load new data to the signal generator channel.*

***2)** The **Reflection pattern multipath** model does not use the standard phase and level patterns. You must implicitly include these patterns in the reflection patterns you use.*


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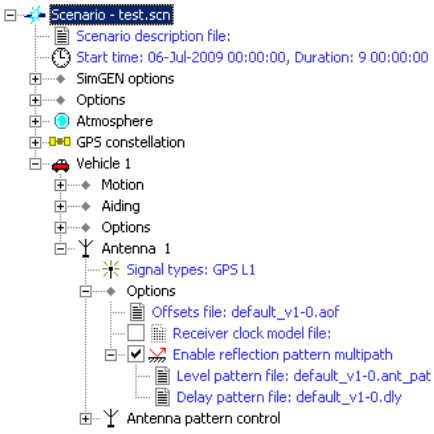
The **Reflection pattern multipath** model uses echoes that you predefine to model reflections from a vehicle that change depending on the vehicle's motion. Use an editor (similar to the editor for ***Receive and transmit antennas*** (page 23-1)) to change the level pattern and delay pattern as a function of their relative arrival angles at the receiver antenna.

Use the **Antenna attenuation pattern** editor to specify additional signal attenuation (in dB relative to the incident level at the antenna) as a level pattern. You must include the level pattern of your antenna when creating the **level pattern file** for your **Reflection pattern multipath**.

The delay pattern defines additional delay in metres using the similar **Antenna delay pattern** editor. You must include the phase pattern of your antenna when creating the **delay pattern file** for your **Reflection pattern multipath**.

To use **Reflection pattern multipath** signals in a scenario, for the vehicle you want to model:

→ Select, then double-click, **Vehicle-Antenna-Options-Enable reflection pattern multipath**



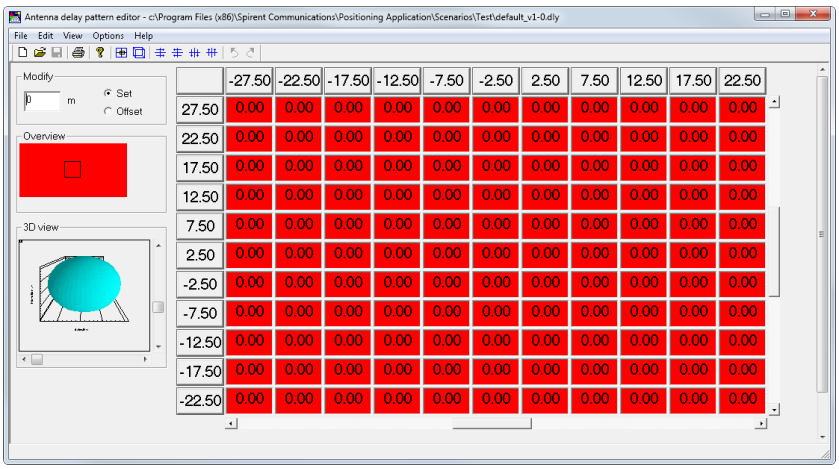

→ Select **Level pattern** file to edit the multipath attenuation.




→ Select **Delay pattern file** to edit the multipath **Delay pattern**.

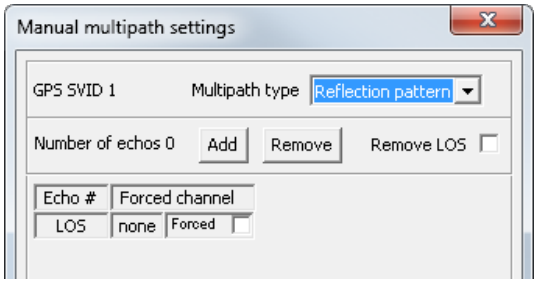


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### 24.4.1 Satellite selection and allocation

Click on the **Channel Assignment** button. In the **Visible satellites** area, find the first satellite SVID you want to use with the **Reflection pattern multipath** model. Click on **State-Multipath-reflection** then click on **Add** to add a multipath signal. The figure below shows the LoS and three echoes.




| | |
|---|---|
| **Remove LOS** | Deselect (default): includes LoS in simulation<br>Select: removes LoS from the simulation |
| **Forced** | Deselect (default): SimGEN allocates multipath signal to any available channel<br>Select: force the multipath signal to a channel you specify.<br>If you do not specify a channel, the next available channel is used. |

## 24.5 Embedded multipath

***Notes**:*

***1)** SimGEN sets the multipath signal OFF in the one second (typically 0.6 seconds) before the off time you specify. This ensures sufficient time to load new data to the signal generator channel.*

***2)** SimGEN cannot start more than eight multipaths (regardless of type) at the same time.*

Embedded multipath uses a User Action file, see ***User Actions file, *.act*** (page 8-38), to allocate up to four sub-channels to one signal generator channel. Each Embedded multipath signal behaves as a simple multipath signal without using a separate signal generator channel. This table shows signal generators with Embedded multipath support. Contact Spirent if you need assistance.

| Signal generator | Comment |
|---|---|
| GSS9000-series | All single- and dual-channel signal generators |
| GSS7000 | A licenced feature, contact Spirent Global Services |
| GSS8000-series | All single- and dual-channel signal generators |
| GSS7800 | All signal generators |
| GSS7700 | Only signal generators from Variant B on - contact Spirent for assistance. |

Each sub-channel has three independent settings that cannot change while the satellite is visible:


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- Attenuation
- Delay
- Carrier phase

You must prepare Embedded multipath signals before starting the scenario. You cannot change the Embedded multipath signals of a satellite while it is visible. You must wait until SimGEN stops simulating the satellite before making changes to it. SimGEN may stop simulating a satellite for a number of reasons, including:

- The satellite sets
- Not enough hardware channels
- The satellite has been **Banned**.

SimGEN applies the new parameters to the satellite before it rises.

***Manual multipath settings*** (page 24-2) details using multipath signals you can change at any time.

### 24.5.1 Comparing Embedded multipath with Manual multipath

This table compares Embedded multipath with Manual multipath signals:

| | Embedded multipath | Manual multipath |
|---|---|---|
| Apply using | User Actions file, see ***Embedded multipath*** (page 24-17) | Channel assignment dialog, see ***Manual multipath settings*** (page 24-2) |
| Present as | A sub-channel of the LoS signal generator channel | Separate signal generator channels for LoS and each multipath |
| Configuration | Up to four sub-channels.<br>Use Sub-channel offsets area to set attenuation, delay and phase for each sub-channel in use | Up to sixteen separate channels.<br>Can set all parameter details for each multipath type |
| LOS signal | Always present.<br>SimGEN adds each defined sub-channel to the LoS, in both amplitude and phase | Can remove LoS signal |
| Set-up | Only before scenario starts | Can set-up during scenario |
| While satellite is visible | Cannot change settings | Can change settings |
| When a satellite sets or rises in a scenario | Satellite will rise with the original settings only if they are unchanged | When a satellite sets, it loses all multipaths. The satellite rises without multipaths |
| Change setting after a satellite has risen? | Only before satellite rises by using a User Action command | Change settings at any time during a scenario |
| Action time | You must ensure the list of Actions is in time-order | At any time during scenario |
| Unwanted signals | Must delete all unwanted signals before scenario starts | Can delete any unwanted signal at any time during scenario |

You can use Embedded multipath signals in conjunction with Manual multipath signals, applying them to the LoS, an echo, or both. The following figure shows three different examples SimGEN applying Embedded multipath signals to a single satellite using a Manual multipath signal comprising the LoS and one echo.

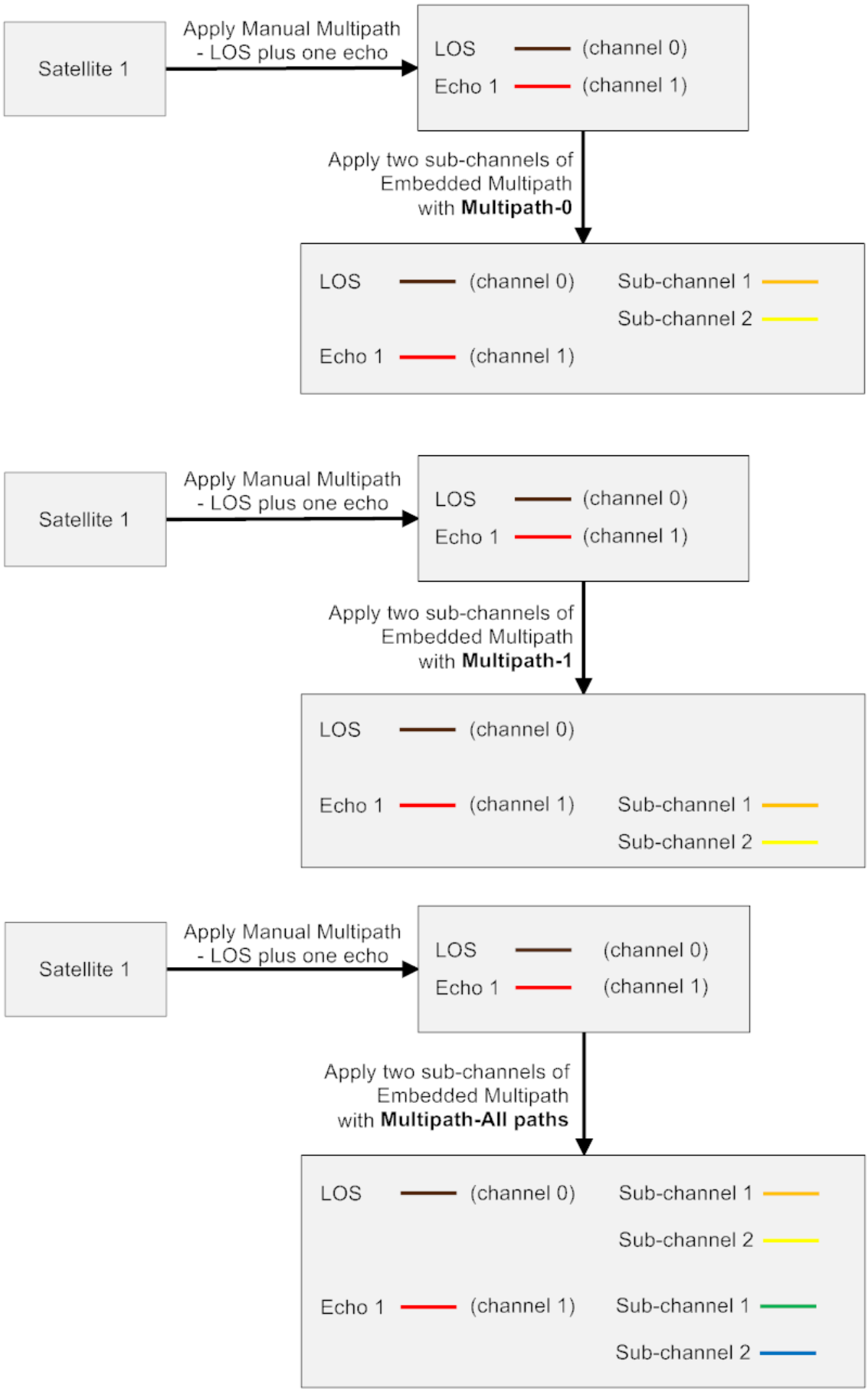
The top drawing shows two Embedded multipath sub-channels applied to signal generator channel 0 using **Multipath-0**. SimGEN applies Embedded multipath signals to the LoS (channel 0) only.

The centre drawing shows two Embedded multipath sub-channels applied to signal generator channel 1 using **Multipath-1**. SimGEN applies Embedded multipath signals to Echo 1 (channel 1) only.



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The lower drawing shows two Embedded multipath sub-channels applied to signal generator channels 0 and 1 using **Multipath-All paths**. SimGEN applies Embedded multipath signals to both LoS (channel 0) and Echo 1 (channel 1).



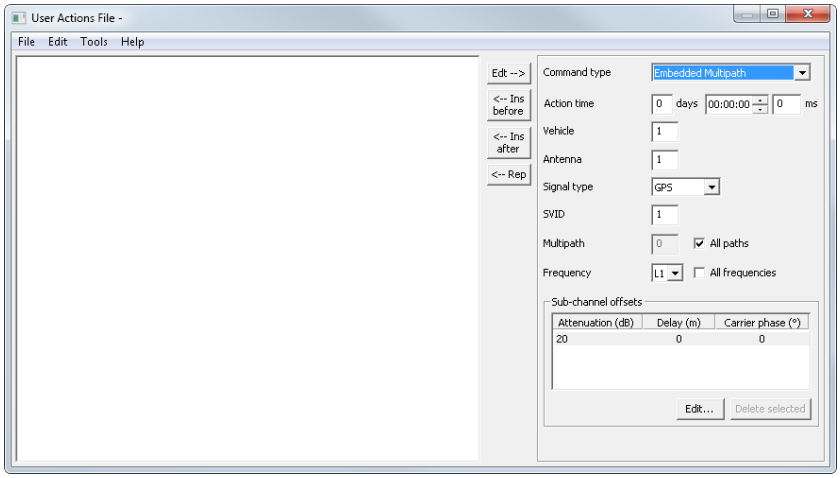


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## 24.5.2 Embedded multipath

***Note**: SimGEN does not request confirmation before deleting a sub-channel. Ensure you select the correct sub-channel before clicking **Delete selected**.*

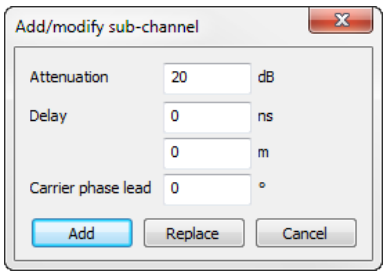
To apply Embedded multipath signals, working in the **Scenario Contents** window, select **Options-User actions file-Command type-Embedded multipath** in the SimGEN ***List Editor*** (page 5-33):




| | | | |
|---|---|---|---|
| **Action time** | The time you want to apply the Embedded multipath signal | | |
| | Units:<br>d hh:mm:ss | Range: 0 00:00:00<br>to 23 23:59:59 | Default: 0 00:00:00 |
| **Vehicle** | The vehicle number to which you want to apply the Embedded multipath | | |
| **Antenna** | The antenna number to which you want to apply the Embedded multipath | | |
| **Signal type** | Choose the signal type to which you want to apply Embedded multipath | | |
| **SVID** | The satellite to which you want to apply the Embedded multipath | | |
| **Multipath** | Applies the Embedded multipath to all **Manual multipaths** or to a single **Manual multipath.**<br><br>All paths:<br>**Selected** (default):Uses all Manual multipaths<br>**Deselect**: Applies the Embedded multipath signal to the multipath number you type in Multipath | | |
| **Frequency** | Select the frequency to which you want to apply the Embedded multipath signal.<br><br>All frequencies<br>Choose from:<br>**Deselect**:(default) choose the frequency from the drop-down list<br>**Select**: apply the Embedded multipath signal to all available frequencies in the **Signal type** you are using | | |


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| | |
|---|---|
| **Sub-channel offsets** | Shows the **Attenuation** (dB), **Delay** (m) and **Carrier phase lead** (°) offsets from the Line-of-Sight signal for up to four sub-channels.<br>By default, one sub-channel is present when you select **Command type-Embedded multipath**. Highlight this sub-channel and click **Edit** to change the default parameters using the **Add/modify sub-channel** dialog, as follows:<br>**Add** click to add a new sub-channel, which appears as a new line in the **Sub-channel offsets** area<br>**Replace** click to replace the original sub-channel parameters with your new entries.<br><br>If you want to add more sub-channels, repeat the process of editing an existing sub-channel and clicking **Add** until you get the number of sub-channels you want to use. After you enter data for the fourth sub-channel, the **Add** button is disabled and you can only **Replace** existing sub-channels or **Delete** selected sub-channels. |




| | | | |
|---|---|---|---|
| **Attenuation** | Units: decibel | Range: 0 to 69.99 dB | Default: 20 |
| **Delay** | You can enter either a delay time in nanoseconds or a delay distance in metres. Each signal generator uses these increments:<br><br>GSS9000-series signal generator: **Delay time** of 8.333 ns = **Delay distance** of 2.498 3 m<br>GSS8000-series signal generator: **Delay time** of 8.146 ns = **Delay distance** of 2.442 1 m<br><br>SimGEN applies the delay you enter as follows:<br>SimGEN rounds the value you typed<br>SimGEN then rounds this value to the nearest delay increment your signal generator supports<br>SimGEN applies this as the **Delay**<br><br>For example, using a GSS9000-series signal generator:<br>You type a value in the range 0 to 4 nanoseconds, SimGEN applies a **Delay** of 0 nanoseconds<br>You type a value in the range 5 to 12 nanoseconds, SimGEN applies a **Delay** of 8.333 nanoseconds | | |
| **Delay** | Units: nanoseconds | Range: 0 to 4 154.448 ns | Default: 0 |
| | Units: metres | Range: 0 to 1 245.472 m | Default: 0 |
| **Carrier phase lead** | Units: degrees | Range: ± 360° | Default: 0 |

## 24.6 Pseudorange ramps

***Note**: If the timing of your pseudorange ramp is critical, Spirent recommends you use* ***Pseudorange ramps using a User Actions file*** *(page 24-24)*

Pseudorange ramps provide a method to introduce controlled errors into a simulation. They are the equivalent to applying a pseudorange error to a satellite. You can add a pseudorange ramp error to any pseudorange signal using the toolbar button **Pseudorange Ramps** or the User Actions file **Command type-PR ramp**.

SimGEN does NOT reflect pseudorange ramps in the navigation data message for the satellite.

This table compares the differences between **Pseudorange Ramps** and **PR ramp**.


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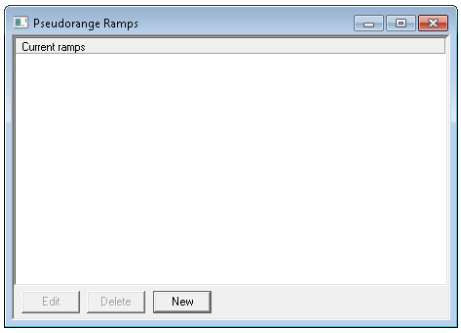
| Description | Pseudorange Ramp (toolbar button) | PR ramp (User Actions file) |
|---|---|---|
| **Save command for re-use?** | No | Yes |
| **Timing accuracy** | Low to medium | Medium to high |

### 24.6.1 Configuring Pseudorange Ramps

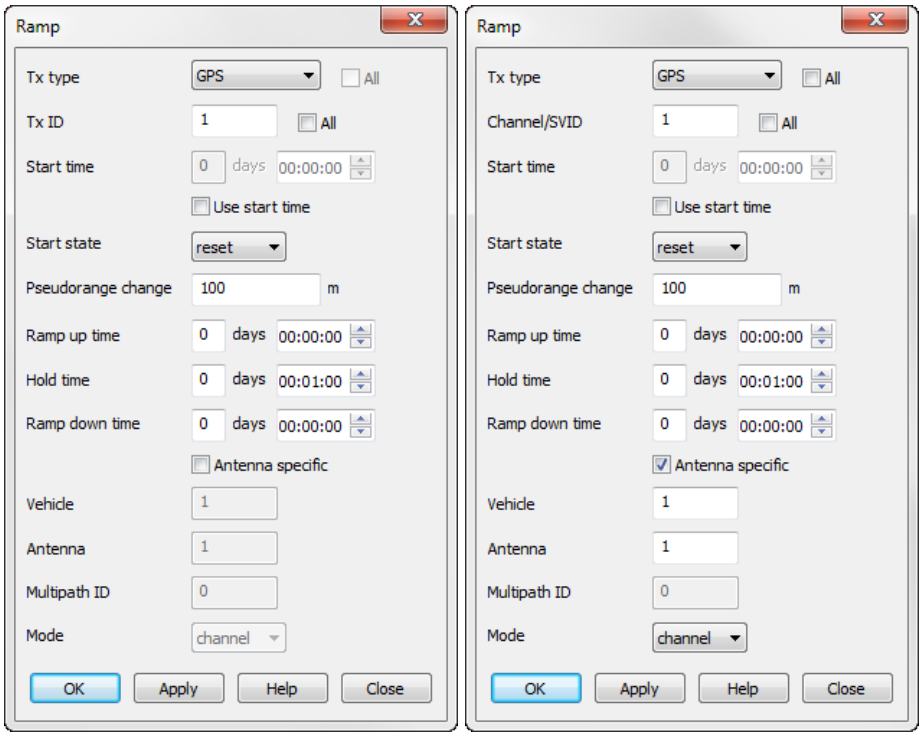
To configure a **Pseudorange ramp**:

→ On the SimGEN toolbar, click the **Pseudorange Ramp** button, 

→ In the **Pseudorange Ramps** dialog, click **New**




→ Type the parameters you want to use in the **Ramp** dialog

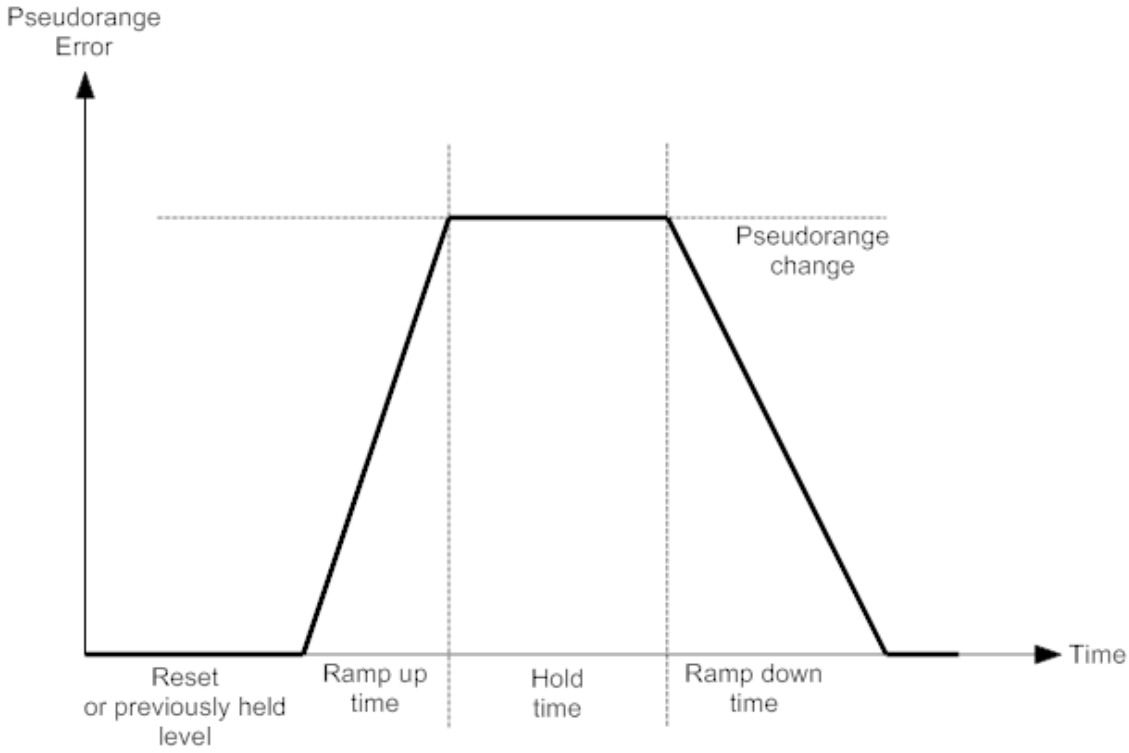



| | |
|---|---|
| **Tx type** | Select the Constellation to which you want to apply pseudorange ramps |
| **All** | **Deselect** (default): applies **PR Ramp** command to the channels / SVID of **Tx type** you specify<br>**Select**: applies **PR Ramp** command all channels / SVID of **Tx type** |


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| | | | |
|---|---|---|---|
| **Tx ID** (**Channel/SVID** when you select **Antenna specific**, see right -hand figure above) | Type the **Tx ID** to which you want to apply a Pseudorange Ramp, SimGEN interprets this as either 'SVID' or 'channel', depending on **Mode**<br><br>**Tx ID** is 'SVID' with **Antenna specific** deselected (the default selection) | | |
| **All** | Click to copy all settings in this dialog to all SVIDs | | |
| **Start time** (into run) | **Deselect** (default): Applies the Pseudorange Ramp immediately you click **OK**<br>**Select**: **Use start time** to enable **Start time** | | |
| | Units:<br>d hh:mm:ss | Range: 0 00:00:00<br>to 23 23:59:59 | Default: 0 00:00:00 |
| **Start state** | Select from **Hold** or **Reset**. | | |
| **Reset** | (default) clears any current action before applying the new ramp | | |
| **Hold** | Uses the current value of any active ramp as a bias and superimposes the new ramp with respect to this.<br>Terminates incomplete phases of the original ramp. | | |
| **Pseudorange change** | The maximum offset involved in applying the ramp, not including any bias involved in using the hold state. | | |
| | Units: metres | Range: ±10 000 000 m | Default: 0 |
| Spirent provides a flexible scheme to enter ramp profiles using three logical phases, **Ramp up time**, **Hold time** and **Ramp down time**. Example ramp profiles:<br>1) Simple step - zero **Ramp-up time** with a very long **Hold time**.<br>2) Sawtooth ramp - finite **Ramp-up time,** zero **Hold-time** and zero **Ramp-down time**.<br>3) Multiple ramps - repeat the waveform at an appropriate interval.<br><br>You can specify trapezoidal, triangular and other profiles in a similar manner. | | | |
| **Ramp up time,**<br>**Hold time,**<br>**Ramp down time** | See the figure below<br>***Note**: These times refer to the duration of the event.* | | |
| | Units:<br>d hh:mm:ss | Range: 0 00:00:00<br>to 23 23:59:59 | Default: 0 00:00:00 (**Ramp up time** and **Ramp down time**)<br>0 00:01:00 (**Hold time**) |
| **Antenna specific** | **Deselected** (default): Applies pseudorange ramps to all vehicles and antennas<br>**Selected** : Applies pseudorange ramps only to the vehicles and antennas you specify below (and changes the label **Tx ID** to **Channel/SVID**, as shown in the right-hand figure above) | | |
| **Vehicle** | Range: 1 to 100 | Default: 1 | |
| **Antenna** | Range: 1 to 100 | Default: 1 | |
| **Multipath ID** | Number of multipath starting at 1 (only enabled in **Mode-svid**)<br>(Notice **Multipath-0** refers to the incident signal) | | |
| | Range: 1 to 100 | Default: 1 | |
| **Mode** | **channel** (default): Use channel mode (in this mode, id = 0-n, the "zero" based channel index, where index 0 corresponds to channel 1)<br>**svid**: Use SVID mode (in this mode, id = 1-n) | | |


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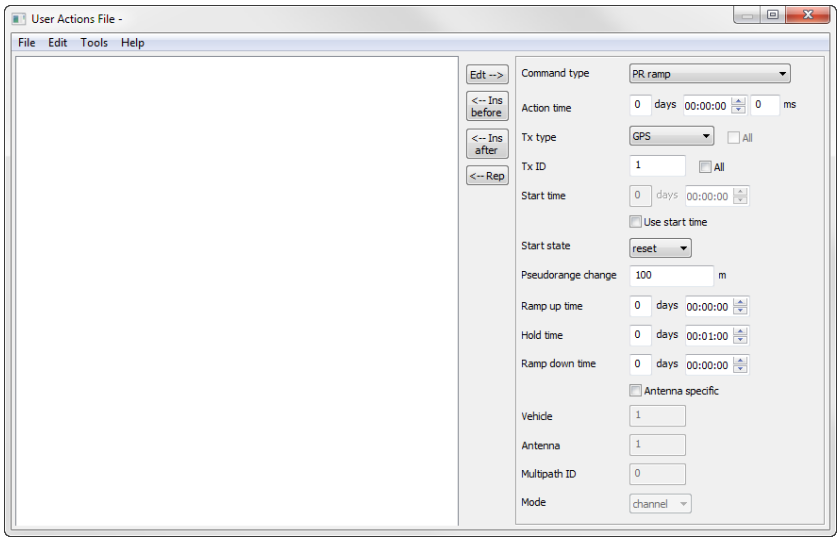



Click **OK** to set the **Pseudorange Ramp**. The new ramp appears in the **Current Ramps** area of the **Pseudorange Ramp** dialog.

Highlight a **Pseudorange Ramp** and click **Edit** to edit the **Pseudorange Ramp** parameters in the **Ramp** dialog.

## 24.6.2 Pseudorange ramps using a User Actions file

Configuring a pseudorange ramp using the SimGEN ***List Editor*** (page 5-33) is very similar to using the tool bar button  . Working in the **Scenario Contents** window, select **Options-User actions file-Command type-PR ramp**. This figure shows the List Editor:




The **PR ramp** parameters are the same as the **Pseudorange ramp** toolbar button, except for the additional parameter **Action time**, which has the same parameters as **Start time**.

You can use **Action time** to schedule in advance a **PR ramp** so the signal generator is “fully prepared” to action the **PR ramp** at **Start time**. This gives the most accurate pseudorange ramp timing. To do this you must select **Use start time** and enter an appropriate **Action time**, which must be at least one second before the **Start time**.

If you only use **Action time**, SimGEN sends the **PR ramp** command to the signal generator at the **Action time** with a possible delay of 100 to 200 milliseconds before the signal generator actions the command.

This table outlines the three methods of starting a pseudorange ramp.



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| Description | Pseudorange Ramp dialog | User Actions file-PR ramp | Comment |
|---|---|---|---|
| Click **OK** | ✓ | ✗ | Clicking **OK** immediately applies the **Pseudorange Ramp**.<br>Timing: Least accurate |
| Use **Action time** | ✓ | ✓ | Applies **Pseudorange Ramp** or **PR ramp** at the **Action time**<br>Timing: to within 100 to 200 milliseconds (for both **Pseudorange Ramp** and **PR ramp**) |
| Use **Action time** and **Start time** | ✗ | ✓ | SimGEN sends the parameters to the hardware at the **Action time**, ready for the command to start at the **Start time**.<br>Timing: precisely at **Start time**.<br><br>***Note**: **Action time** must be at least one second before the **Start time** you want to use.* |


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# 25 Accessing simulation (Quick-Look) data

In addition to the scenario characteristics (such as ground track, Sky Plot, and GPS signal data) that SimGEN displays during a run, you can get more data items through SimGEN's extensive logging capabilities. This logging can take the form of tables or plots that Spirent call Quick-Look data. This Chapter describes Quick-Look data and logging data for post-processing.

You can use post-processing techniques to store and access Quick-Look data after finishing your run. Alternatively, you can use Data Streaming to pass Quick-Look data to other applications, in real-time over Ethernet, using the ***Data streaming definition file*** (page 8-6) and the UDP/IP transport protocol and reference qq). Data Streaming gives you control over where SimGEN ends the data, how fast it sends the data and what data it sends.

Post-processing data files use ASCII comma-separated variable (**.csv*) format. For further manipulation, you can import these data files to Excel or MatLab.

Reference zz) details post-processing using SimPROCESS.

## 25.1 Keywords

***Notes**:*

***1)** You can specify Signal data items using channel or TX ID (SVID for GPS satellites). You must determine the currently simulated satellites to make a meaningful SVID selection. If a satellite is not present, data displays as "zero".*

***2)** All Quick-Look data keywords use the current run-time (which is equivalent to GPS time at the receiver).*

Quick Look data uses keyword sets to define the data for use. For each top-level keyword you use, you must also complete the enabled parameters for the second-level keyword. The following table gives the top-level keywords:

| Keyword | Description |
|---|---|
| ***Quick look - Antenna*** (page 25-4) | Relates to antenna position<br>You can offset the antenna from the vehicle CofG or its centre of motion. |
| ***Quick look - Interferer*** (page 25-10) | Only available when you select ***Vehicle-Antenna-Signal types-Interference*** see reference nn). You must enter the location of the interfering source. |
| ***Quick look - Signal*** (page 25-6) | The transmitter-to-antenna signal characteristics, such as pseudorange, or pseudorange rate.<br>You can record signal data for L1, L2 and L5 frequencies.<br><br>You must unambiguously select a data item by also selecting:<br>**Vehicle** - select the vehicle number.<br>**Antenna** - select the antenna number.<br>**UUT** - type the identity number of the Unit Under Test<br>**Tx type** - select the satellite type.<br>**Frequency** - select the frequency in use; or you can select the channel if required.<br>**Tx ID / channel** - type the channel you want to use.<br>**Multipath** - select to use multipath and type the Reflection ID you want to use. |
| **Quick look - SimINERTIAL** | ***Note**: Currently, SimINERTIAL does not support Quick Look keywords. Ignore text that appears to represent keywords in this dialog* |
| ***Quick look - Time*** (page 25-2) | Time related parameters, such as GPS time |
| ***Quick look - Transmitter*** (page 25-5) | Relates to signal transmitters<br>Currently SimGEN only supports Galileo, GLONASS, GPS and SBAS satellites. |


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| Keyword | Description |
|---|---|
| ***Quick look - UUT*** (page 25-8) | Test data from a Unit Under Test (UUT), such as a GNSS receiver. SimGEN receives data from the UUT using an NMEA interface see ***Displaying receiver errors using SimGEN*** (page 8-10), or a Socket interface - see reference qq). |
| ***Quick look - Vehicle*** (page 25-3) | Data related to the notional centre of gravity (CofG) or centre of motion of the vehicle. This is the point of propagation for the vehicle motion. |
| ***Quick look - Interference signal*** (page 25-10) | Only available when you select ***Vehicle-Antenna-Signal types-Interference*** see reference nn). You must enter details of the interfering signal. |

Many keywords give you the option to use different units. The dialog includes a drop-down box next to **Add selected**. Choose from one of the units shown. The Keyword tables detail the default units.

The following sections detail the keywords available in each dialog. The keyword sections in the **Data for plotting**, **Data for display** and **Data for logging** windows are similar.

## 25.2 Quick look - Time

***Notes***:

***1)*** *The Quick-Look data log file automatically includes a* ***Time*** *field. The* ***Time*** *field is the time into scenario.*

***2)*** *Values for keyword* ***Time into Run*** *will always be just prior to* ***Time*** *- the difference depends on the logging rate.*

***3)*** ***Time into run*** *is never equal to, or after,* ***Time****.*

***4)*** *The setting you select for Simulation Iteration Rate (see* ***General Options*** *(page 5-15)) determines the resolution of tow (time of week).*

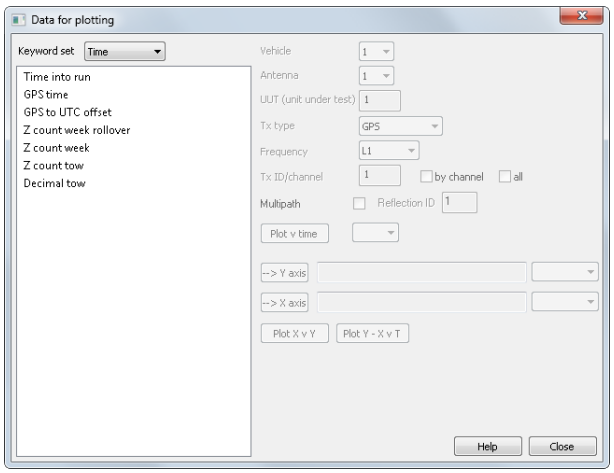
This table shows **Time** keywords

| Keyword | Description (units) |
|---|---|
| Decimal tow | Logs the 'real' time of week timestamp (initial TOW at the start of the scenario + time into run) in the quick look log |
| GPS time | See, for example, reference b) |
| Time into run | The time into scenario when SimGEN completes calculation of data that is valid at **Time**, see Notes above (seconds) |
| UTC time | Universal Time Co-ordinated |
| Z count tow | See, for example, reference b) |
| Z count week | See, for example, reference b) |
| Z count week rollover | See, for example, reference b) |

This figure shows the **Time** keywords in the **Data for plotting** dialog



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## 25.3 Quick look - Vehicle

***Note**: The* difference between the ***Vehicle*** *keywords ECEF X position, ECEF Y position and ECEF Z position and the* ***Signal*** *keywords ECEF X position, ECEF Y position and ECEF Z position gives the true range, rather than pseudorange.*

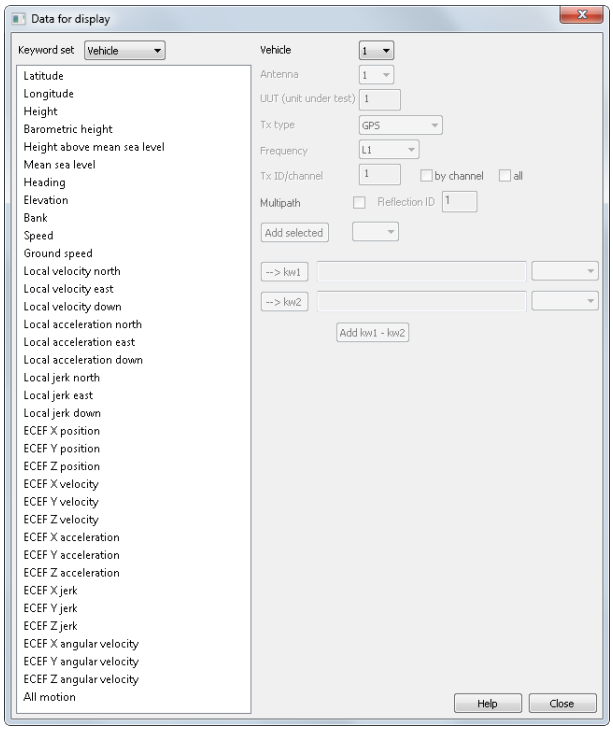
This table shows **Vehicle** keywords.

| Keyword | Description (units) |
|---|---|
| All motion | Selects all the vehicle keywords |
| Bank | Vehicle bank, in Local Geodetic co-ordinates (radians) |
| Barometric height | Height reported by Barometric model (see ***Barometric height serial output file*** (page 8-2), if employed (metres) |
| ECEF X acceleration,<br>ECEF Y acceleration,<br>ECEF Z acceleration | Acceleration of the vehicle with respect to the ECEF frame expressed in ECEF axes<br>($m.s^{-2}$) |
| ECEF X angular velocity,<br>ECEF Y angular velocity,<br>ECEF Z angular velocity | Angular velocity of the vehicle with respect to the ECEF frame expressed as rotation about the body axes<br>($rad.s^{-1}$). |
| ECEF X jerk,<br>ECEF Y jerk,<br>ECEF Z jerk | Jerk of the vehicle with respect to the ECEF frame expressed in ECEF axes<br>($m.s^{-3}$). |
| ECEF X position,<br>ECEF Y position,<br>ECEF Z position | Position of the vehicle with respect to the ECEF co-ordinate frame (rotates with the Earth).<br>(m) |
| ECEF X velocity,<br>ECEF Y velocity,<br>ECEF Z velocity | Velocity of the vehicle with respect to the ECEF frame expressed in ECEF axes<br>($m.s^{-1}$) |
| Elevation | Vehicle elevation, in Local Geodetic co-ordinates (radians) |
| Ground speed | Vehicle speed measured on ground ($m.s^{-1}$) |
| Heading | Vehicle heading, in Local Geodetic co-ordinates (radians) |
| Height | Height of the vehicle with respect to WGS84 ellipsoid (metres) |
| Height above mean sea level | Spirent bases the calculation of mean sea level on the EGM2008 geoid offsets from the WGS84 ellipsoid (metres) |
| Latitude | Latitude of the vehicle with respect to WGS84 ellipsoid (metres) |
| Local velocity down | Velocity local to vehicle - down ($m.s^{-1}$) |


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| Keyword | Description (units) |
|---|---|
| Local velocity east | Velocity local to vehicle - east direction ($m.s^{-1}$) |
| Local velocity north | Velocity local to vehicle - north direction ($m.s^{-1}$) |
| Longitude | Longitude of the vehicle with respect to WGS84 ellipsoid (metres) |
| Mean sea level | Spirent bases the calculation of mean sea level on the EGM2008 geoid offsets from the WGS84 ellipsoid (metres) |
| Speed | Vehicle speed ($m.s^{-1}$) |

This figure shows the **Vehicle** keywords in the **Data for display** dialog




## 25.4 Quick look - Antenna

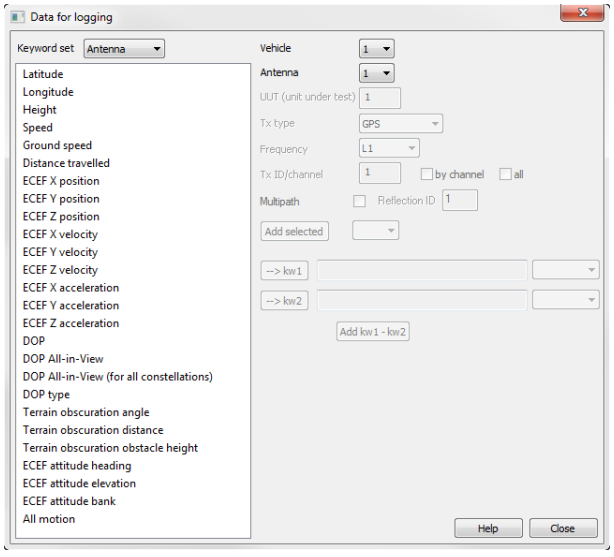
This table shows **Antenna** keywords:

| Keyword | Description (units) |
|---|---|
| All motion | Selects all the antenna keywords |
| Distance travelled | Total distance travelled in three dimensions (metres) |
| DOP | For the best four satellites in the constellation you select in **Tx type** (which shows the constellations in your scenario) plot, log and/or display the DOP for your selection in **[constellation]signal sources-Satellite selection-DOP type** |
| DOP All-in-View | For all satellites in view, of the constellation you select in **Tx type** (which shows the constellations in your scenario), plot, log and/or display the DOP type you select in **[constellation]signal sources-Satellite selection-DOP type** |
| DOP All-in-View (for all constellations) | For all satellites in view for all constellations in your scenario, plot, log and/or display the DOP type you select in **[constellation]signal sources-Satellite selection-DOP type**, for the constellation you select in **Tx type** (which shows the constellations in your scenario) |


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| Keyword | Description (units) |
|---|---|
| DOP type | For all satellites of the constellation you select in **Tx type** (which shows the constellations in your scenario), log and/or display the DOP type (one of HDOP, PDOP, VDOP, TDOP or GDOP) you select in **[constellation]signal sources-Satellite selection-DOP type**. |
| ECEF X acceleration,<br>ECEF Y acceleration,<br>ECEF Z acceleration, | Acceleration of the antenna with respect to the ECEF frame expressed in ECEF axes ($m.s^{-2}$) |
| ECEF X position,<br>ECEF Y position,<br>ECEF Z position | Position of the antenna with respect to the ECEF co-ordinate frame (rotates with the Earth).<br>(m) |
| ECEF X velocity,<br>ECEF Y velocity,<br>ECEF Z velocity, | Velocity of the antenna with respect to the ECEF frame expressed in ECEF axes ($m.s^{-1}$) |
| Ground speed | Vehicle speed measured on ground ($m.s^{-1}$) |
| Height | Height of antenna with respect to the WGS84 ellipsoid (radians) |
| Latitude | Latitude of antenna with respect to the WGS84 ellipsoid (radians) |
| Longitude | Longitude of antenna with respect to the WGS84 ellipsoid (radians) |
| Speed | Speed measured by vehicle ($m.s^{-1}$) |
| Terrain obscuration angle | See ***Application of Terrain obscuration*** (page 21-67) (radians) |
| Terrain obscuration distance | See ***Application of Terrain obscuration*** (metres) |
| Terrain obscuration obstacle height | See ***Application of Terrain obscuration*** (metres) |
| ECEF attitude heading,<br>ECEF attitude elevation,<br>ECEF attitude bank | Attitude of antenna with respect to the ECEF frame (radians) |

This figure shows the **Antenna** keywords in the **Data for logging** dialog:





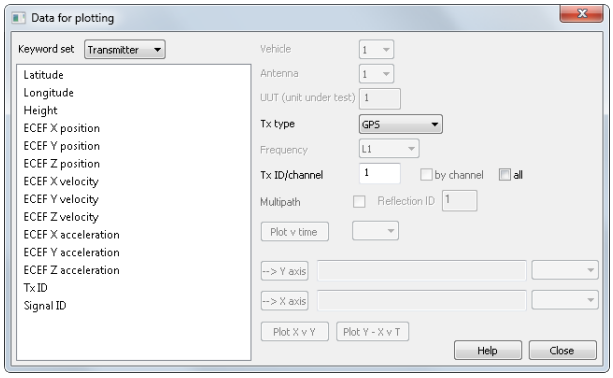
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## 25.5 Quick look - Transmitter

This table shows **Transmitter** keywords.

| Keyword | Description (units) |
|---|---|
| Latitude | Latitude of transmitter with respect to the WGS84 ellipsoid (radians) |
| Longitude | Longitude of transmitter with respect to the WGS84 ellipsoid (radians) |
| Height | Height of transmitter with respect to the WGS84 ellipsoid (metres) |
| ECEF X position,<br>ECEF Y position,<br>ECEF Z position | Position of the transmitter with respect to the ECEF co-ordinate frame (rotates with the Earth).<br>(m) |
| ECEF X velocity,<br>ECEF Y velocity,<br>ECEF Z velocity, | Velocity of the transmitter with respect to the ECEF frame expressed in ECEF axes ($m.s^{-1}$) |
| ECEF X acceleration,<br>ECEF Y acceleration,<br>ECEF Z acceleration, | Acceleration of the transmitter with respect to the ECEF frame expressed in ECEF axes<br>($m.s^{-2}$) |
| ECEF position | ECEF position (X, Y, Z) of the transmitter position |
| Tx ID | Equivalent to GPS SVID |
| Signal ID | Equivalent to GPS PRN |

This figure shows the **Transmitter** keywords in the **Data for plotting** dialog




## 25.6 Quick look - Signal

***Notes***:

***1)*** *The **Signal** keywords ECEF X position, ECEF Y position and ECEF Z position give the location of the satellite when it transmitted the signal "element" currently being received (at the data reference time). The position relates to the ECEF frame defined at the reference time and so includes the effect of Earth rotation (the Sagnac effect) over the transmission interval.*

***2)*** *The* difference between the ***Signal*** *keywords ECEFX position, ECEF Y position and ECEF Z position, and the **Vehicle** keywords ECEFX position, ECEF Y position and ECEF Z position gives the true range, rather than pseudorange.*

***3)*** *The **Signal** keywords ECEFX position, ECEF Y position and ECEF Z position contain the same data as the bulk logged satellite ECEF data; see the menu item **Options-Bulk logging options-ASCII output file descriptions-Satellite data** (page 5-1) and **Options-Bulk logging options-Binary output file descriptions-Satellite data**.*

This table shows **Signal** keywords.

| Keyword | Description (units) |
|---|---|
| All signal parameters | Selects all the Signal keywords |

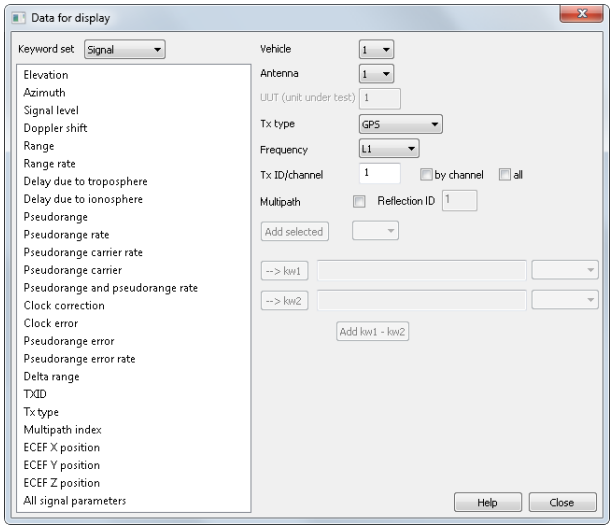

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| Keyword | Description (units) |
|---|---|
| Azimuth | Azimuth arrival angle of the satellite signal, in the local geodetic frame (radians) |
| Clock corrections | Equal to Af0 + Af1*t + Af2*$t^2$<br><br>Where: t = GPS time at time of transmission - reference time.<br><br>For example, use **GPS-*Motion - Clock errors*-Clock corrections** (page 10-37) to select reference time as either the scenario start time, or the orbit reference time. Then; and enter any Af terms you want to use in the scenario. |
| Clock errors | Equal to Clock corrections + Clock divergence<br><br>Where:<br>Clock corrections - see above<br>Clock divergence = Delta Af0 + Delta Af1*($t_1$) + Delta Af2*($t_2$)$^2$<br>$t_1$ = time-into-run - 'effective from' time for Delta Af1<br>$t_2$ = time-into-run - 'effective from' time for Delta Af2<br><br>Use [constellation editor] **Motion-Clock errors-Clock divergence** to first enable **Clock divergence** and then enter the values of **Delta Af0** to **Delta Af2**, and their **effective from** times, you want to use in your scenario.<br><br>SimGEN does not apply clock divergence for $t_1$ and $t_2$ less than zero. |
| Delay due to Ionosphere | GPS signal delay in the Ionosphere, see ***Atmosphere file*** (page 9-1) (metres) |
| Delay due to Troposphere | GPS signal delay in the Troposphere, see ***Atmosphere file*** (metres) |
| Delta range | Change in satellite range over a time interval plus the change in the satellite clock over the same time interval.<br>Division by the time interval gives units (m.$s^{-1}$.) |
| Doppler shift | Pseudorange rate converted to frequency (Hz) |
| ECEF X position,<br>ECEF Y position,<br>ECEF Z position | Position of the signal source with respect to the ECEF co-ordinate frame (rotates with the Earth).<br>(m) |
| Elevation | Elevation arrival angle of the satellite signal, in the local geodetic frame (radians) |
| Multipath index | The path number (you must also select Multipath)<br>0 for a direct path (no multipath) |
| Pseudorange | Simulated signal delay (metres) |
| Pseudorange and Pseudorange rate | Logs both these keywords |
| Pseudorange carrier | Pseudorange on carrier component of signal (metres) |
| Pseudorange error | Error in the simulated signal delay (metres) |
| Pseudorange error rate | Rate of change of the error in the simulated signal delay (m.$s^{-1}$) |
| Pseudorange rate | Rate of change of simulated signal delay (m.$s^{-1}$) |
| Range | Satellite range (metres). |
| Range rate | Rate of change of range (m.$s^{-1}$) |


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| Keyword | Description (units) |
|---|---|
| Signal level | Signal level (dB) |
| Tx type | Logs signal type (GPS / Galileo and so on) if more than one signal type used |
| TXID | Equivalent to GPS SVID |

This figure shows the **Signal** keywords in the **Data for display** dialog




## 25.7 Quick look - UUT

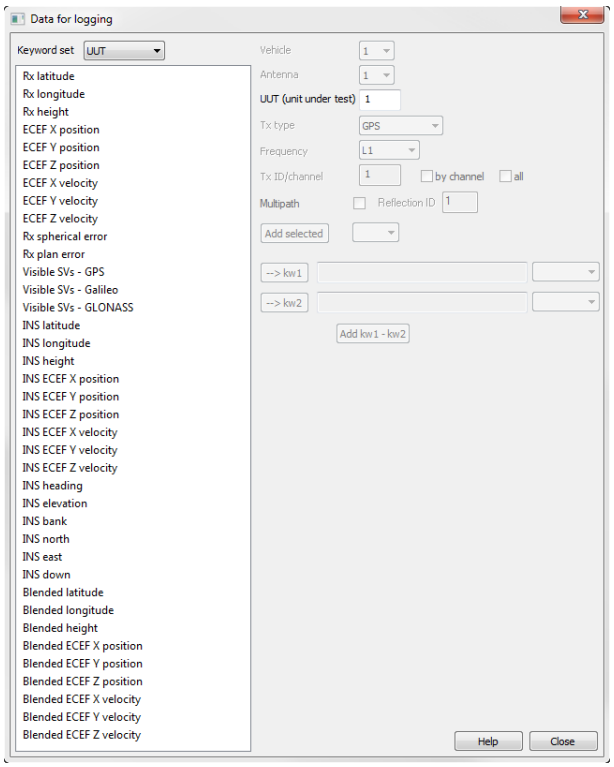
This table shows **UUT** keywords.

| Keyword | Description (units) |
|---|---|
| Rx latitude | Latitude of receiver with respect to the WGS84 ellipsoid (radians) |
| Rx longitude | Longitude of receiver with respect to the WGS84 ellipsoid (radians) |
| Rx height | Height of receiver with respect to the WGS84 ellipsoid (metres) |
| ECEF X position,<br>ECEF Y position,<br>ECEF Z position | Position of the receiver with respect to the ECEF co-ordinate frame (rotates with the Earth).<br>(m) |
| ECEF X velocity,<br>ECEF Y velocity,<br>ECEF Z velocity, | Velocity of receiver with respect to the ECEF frame expressed in ECEF axes<br>($m.s^{-1}$) |
| Rx spherical error | Error projected as a sphere (metres) |
| Rx plan error<br>Rx plan error east<br>Rx plan error north<br>Rx plan error height | Error projected onto ground plane (metres)<br><br>A North-East plot shows the receiver location<br>Use to plot height error |
| Visible SV's -GPS<br>Visible SV's - Galileo<br>Visible SV's - GLONASS | Uses NMEA input from receiver under test to display number of visible satellites receiver reports |
| INS latitude | Latitude of INS with respect to the WGS84 ellipsoid (radians) |
| INS longitude | Longitude of INS with respect to the WGS84 ellipsoid (radians) |
| INS height | Height of INS with respect to the WGS84 ellipsoid (metres) |


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| | |
|---|---|
| INS ECEF X position,<br>INS ECEF Y position,<br>INS ECEF Z position | Position of the INS with respect to the Earth Centred Earth Fixed co-ordinate frame (rotates with the Earth).<br>(m) |
| INS ECEF X velocity,<br>INS ECEF Y velocity,<br>INS ECEF Z velocity, | Velocity of the INS with respect to the ECEF frame expressed in ECEF axes<br>($m.s^{-1}$) |
| INS heading | INS heading in Local Geodetic co-ordinate (radians). |
| INS elevation | INS elevation in Local Geodetic co-ordinate (radians). |
| INS bank | INS bank in Local Geodetic co-ordinate (radians). |
| INS north | Position North reported by INS ($m.s^{-1}$) |
| INS east | Position East reported by INS ($m.s^{-1}$) |
| INS down | Position down reported by INS ($m.s^{-1}$) |
| Blended latitude | Composite of the reported GPS and INS latitude (radians) |
| Blended longitude | Composite of the reported GPS and INS longitude (radians) |
| Blended height | Composite of the reported GPS and INS height (metres) |
| Blended ECEF X position,<br>Blended ECEF Y position,<br>Blended ECEF Z position | Composite of the reported GPS and INS ECEF positions (metres) |
| Blended ECEF X velocity,<br>Blended ECEF Y velocity,<br>Blended ECEF Z velocity, | Composite of the reported GPS and INS ECEF velocities<br>($m.s^{-1}$) |

This figure shows the **UUT** keywords in the **Data for logging** dialog:





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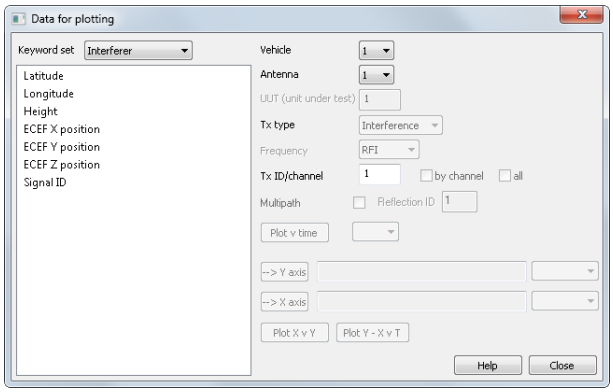
## 25.8 Quick look - Interferer

Available after you select **Vehicle-Antenna-Signal types-Interference**.

This table shows **Interferer** keywords.

| Keyword | Description (units) |
|---|---|
| ECEF X position,<br>ECEF Y position,<br>ECEF Z position | Position of the signal source with respect to the ECEF co-ordinate frame (rotates with the Earth). |
| Height | Height of transmitter with respect to the WGS84 ellipsoid (metres) |
| Latitude | Latitude of transmitter with respect to the WGS84 ellipsoid (radians) |
| Longitude | Longitude of transmitter with respect to the WGS84 ellipsoid (radians) |
| Signal ID | Signal ID for a specific vehicle and antenna |

This figure shows the **Interferer** keywords in the **Data for plotting** dialog




## 25.9 Quick look - Interference signal

Available after you select **Vehicle-Antenna-Signal types-Interference**.

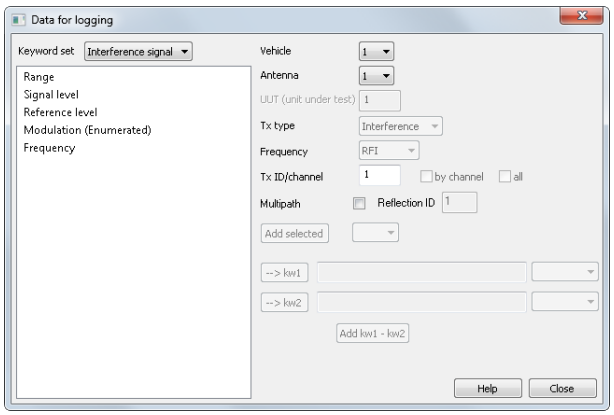
This table shows **Interference signal** keywords.

| Keyword | Description (units) |
|---|---|
| Frequency | Frequency of interference signal (Hz) |
| Modulation (enumerated) | Modulation type given as a number |
| Range | Range of the interference signal (metres) |
| Reference level | Reference level (dBm) |
| Signal level | Signal level of interference signal (dB) |

This figure shows the **Interferer** keywords in the **Data for plotting** dialog



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## 25.10 Log data to a file

***Note**: From SimGEN version 2-83 onward, you must connect a valid Spirent signal generator to the SimGEN Controller, or install a "no hardware licence", to enable data logging to a file when you run any scenario in **No hardware ("dummy run")** mode.*

SimGEN produces data while it runs your scenario. You can log specific items of data to a file by selecting one or more keywords.

Working in the SimGEN main window:

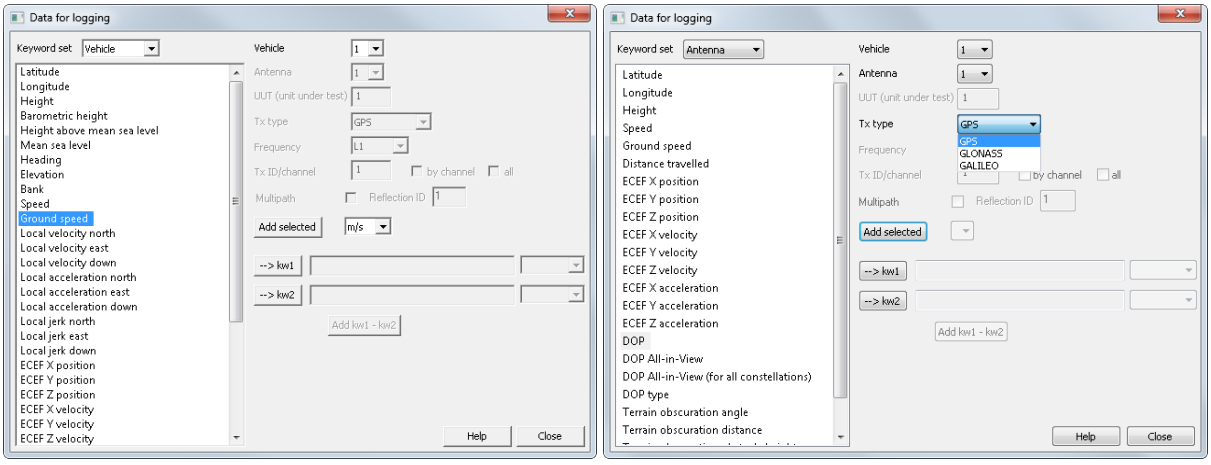
→ Click the Data Logging Control toolbar button, 

→ Click **Data Plots-Add…**

→ The **Data for logging** dialog appears.

→ Select the top-level ***Keywords*** (page 25-1) you want to plot in the **Keyword set** text box.

→ The top-level keyword in the left-hand figure is **Vehicle**. The right-hand figure shows the top-level keyword **Antenna** and shows the **DOP-Tx type** dropdown, where you can choose the constellation from those available in scenario:




→ Select the second-level keyword you want to plot. The second-level **Antenna** keyword in the left-hand figure above is **Ground speed**.

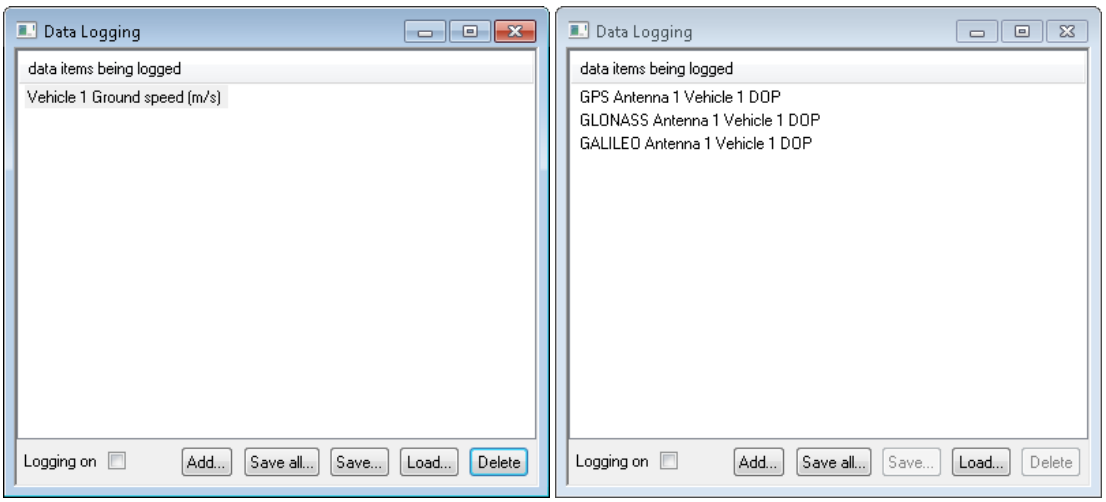
→ Now choose what you want to log from the enabled parameters in the right-hand area of the dialog. The figure above shows logging of **Vehicle-1** and ground speed units of **m.s$^{-1}$**.
***Note**: Not all keyword parameters are enabled for all keywords*.

→ Click **Add selected** to log these keywords.

→ If required, select further top-level, second-level keywords and logging parameters.

→ When you have finished selecting keywords and log parameters click **Close**. The **Data Logging** dialog shows the data for logging and the units, as in these figures:


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To delete an entry in the **Data Logging** dialog, highlight it and click **Delete**.

In addition, you can:

- Select two keywords (and their units) by clicking →**kw1** and →**kw2** as appropriate
- After selecting each keyword, select the units you want to use from those displayed in the right-hand text box. Click **kw1** → or **kw2** → as appropriate. This example uses **Antenna 1 Vehicle 1 Ground speed** as **kw 1** and **Antenna 1 Vehicle 1 ECEF X velocity** as **kw2**
- Log the difference in the keywords (kw1-kw2) by clicking **Add kw1-kw2**
- The **Data Display** dialog shows the **kw1-kw2** selection you made together with the value of the data and the units. This is the third line in the figure above

Quick Look logging has these limitations:

- The Simulation Iteration Rate, see ***General Options*** (page 5-15), limits the number of key words SimGEN can log, especially if you use one millisecond Simulation Iteration Rate. SimGEN limits the time it uses for Quick Look logging to no more than 5% of the Simulation Iteration Rate.
  If this limit is exceeded, SimGEN displays the message “Too many Quick Look items to log within scenario iteration rate, not all items will be logged” in the ***System Messages*** windows (page 3-15).
  Notice SimGEN displays this message only once during a run, when the 5% limit is first exceeded; this may not occur immediately due to the variable time taken to perform logging.
- You must use a longer Simulation Iteration Rate to log more data (for example, changing from 10 milliseconds to 100 milliseconds).
  Reducing the logging rate does not allow you to log more data.
- The amount of data that SimGEN can log depends on the speed of your C50r SimGEN Host (especially if you use a SimGEN Controller).

### 25.10.1 Save and load Quick Look logged (*.qll) files

By saving the list of logged keywords, the next time you run the scenario you can log the same keywords without re-defining them. The Quick-Look log file uses the extension **.qll*.

- To save all the keywords, click on **Save All**
- To save a number of individual keywords, press <ctrl> and click on the keywords you want to select and click **Save**
- To save a range of keywords, click on the first keyword, press <shift> and click on the last keyword
- To load a **.qll* file, click **Load** and select the Quick-Look display file you want to use
- Select **Logging On** to enable logging
- You can switch Logging on and off throughout the scenario



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→ Selecting **Logging On** can override the selection of **Logging Enable**, see ***Quick Look (*.qlk) file*** (page 25-15)

## 25.11 Displaying run-time data

SimGEN produces data while it runs your scenario. You can display specific items of data by selecting one or more keywords.

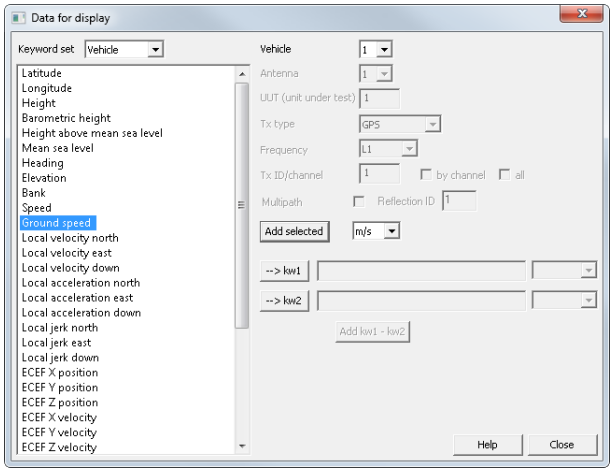
Working in the SimGEN main window:

To select data for display:

→ Click the Data Display toolbar button, 

→ Click **Data Display-Add…**

→ The **Data for display** dialog appears




→ Select the top-level ***Keywords*** (page 25-1) you want to plot in the **Keyword set** text box. The top-level keyword in the figure above is **Vehicle**

→ Select the second-level keyword you want to plot. The second-level keyword in the figure above is **Ground speed**

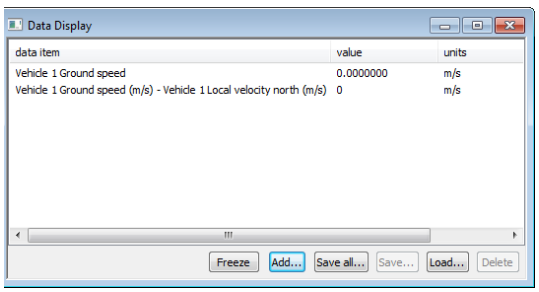
→ Now choose what you want to plot from the enabled parameters in the right-hand area. The figure above shows selection of **Vehicle-1** and the ground speed units of **m/s**
***Note**: Not all these parameters are enabled for all keywords*

→ Click **Add selected**

→ If required, select further top-level, second-level keywords and plot parameters

→ Click **Close**. The **Data Display** dialog shows the data selection you made together with the value of the data and the units

→ To delete an entry in the **Data Display** dialog, highlight it and click **Delete**




In addition, you can:


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- Select two keywords to display. After selecting each keyword, select the units you want to use from those displayed in the right-hand text box. Click **kw1** (or **kw2**) as appropriate. This example uses **Vehicle 1 Ground speed** as **kw1** and **Vehicle 1 Local velocity north** as **kw2**
- Display the difference in the keywords (**kw1-kw2**) by clicking **Add kw1-kw2**
- The **Data Display** dialog shows the **kw1-kw2** selection you made together with the value of the data and the units. This is the second line in the figure above.
- Clicking **Freeze** freezes the data display and the button text changes to **Resume**.
- Click **Resume** to resume displaying data.
- Notice there must be at least one **data item** present to enable **Freeze**.

### 25.11.1 Save and load Quick Look display (*.qld) files

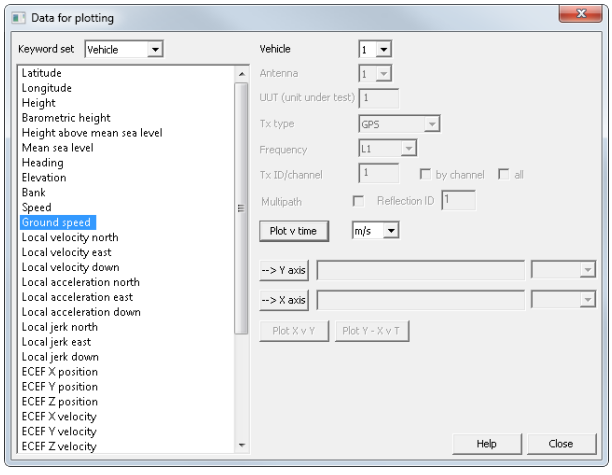
By saving the list of displayed data, the next time you run the scenario you can display the same data without re-defining them. The Quick-Look display file uses the extension **.qld*.

- To save all the keywords, click on **Save All**
- To save a number of individual keywords, press <ctrl> and click on the keywords you want to select
- Click **Save**
- To save a range of keywords, click on the first keyword, press <shift> and click on the last keyword
- To load a **.qld* file, click **Load** and select the Quick-Look display file you want to use

## 25.12 Plotting data versus time

To plot data versus time:

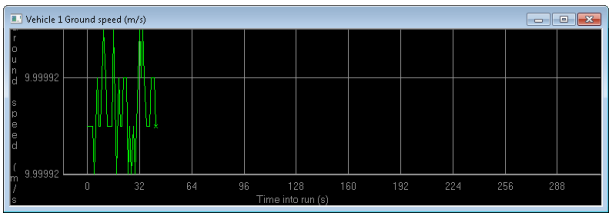
- Click the Data plot control toolbar button, 
- Click **Data Plots-Add…**
- The **Data for plotting** dialog appears




- Select the top-level ***Keywords*** (page 25-1) you want to plot in the Keyword set text box. The top-level keyword in the above figure is **Vehicle**
- Select the second-level keyword you want to plot. The second-level keyword the above figure is **Ground speed**
- Now choose what you want to plot from the enabled parameters in the right-hand area. The above figure shows selection of **Vehicle-1** and the ground speed units of **m/s**
  ***Note**: Not all keywords enable all these parameters*


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- Click **Plot v time** to show (for the example keyword in the above figure of **Vehicle Ground speed**) plotted automatically against **time into run (s)** in SimGEN. The figure below shows the plot of **Ground speed** against time, which auto-scales as required




- You can plot multiple items and a plot of each item appears in its own window. To display a second plot, select the keywords you want to use and click **Plot v time**
- When you have finished selecting keywords and plot types, click **Close**
- To delete an entry in the **Data for plotting** dialog, highlight it and click **Delete**

In addition, you can:

- Select keywords to plot as the Y- and X-axes in the plot shown in SimGEN. After selecting each keyword, select the units you want to use from those displayed in the right-hand text box. Click **Y axis →** or **X axis →** as appropriate
- Plot the keywords you selected for the X-axis versus the Y-axis by clicking **Plot X v Y**. For example, you can plot latitude versus longitude to produce a ground track plot
- Plot the difference in the keywords you selected for the Y-axis and the X-axis against time by clicking **Plot Y-X v T**

### 25.12.1 Save and load Quick Look plot (*.qlp) files

By saving the list of plots, the next time you run the scenario you can display the same plots without re-defining them. The Quick-Look display file uses the extension **.qlp*.

- To save all the keywords, click on **Save All**
- To save a number of individual keywords, press <ctrl> and click on the keywords you want to select and click **Save**
- To save a range of keywords, click on the first keyword, press <shift> and click on the last keyword
- To load a **.qlp* file, click **Load** and select the Quick-Look plot file you want to use

## 25.13 Quick Look (*.qlk) file

***Notes**:*

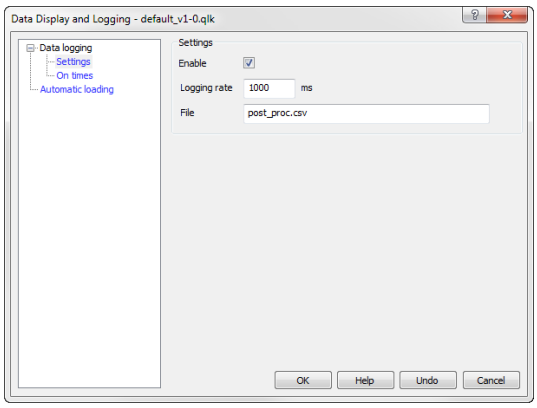
***1)** From SimGEN version 2-83 onward, you must connect a valid Spirent signal generator to the SimGEN Controller, or install a "no hardware" licence" to enable data logging to a file when you run any scenario in **No hardware ("dummy run")** mode.*

***2)** SimGEN overwrites this file each time you run the scenario. To retain the data, you must rename the file or copy it to a different folder.*

***Log data to a file*** (page 25-11) defines how you select data to log to a file. This section details how you define the logging rate and save the log file. The log file can also store the names of display and plot data definitions for re-use when you repeat the scenario.

Starting the scenario creates the default data display and logging file, *default_vx-yy.qlk*. Access this file by selecting it in the **Scenario contents** window using **Options-Data display and logging file: default_vx-yy.qlk** and double-clicking it.

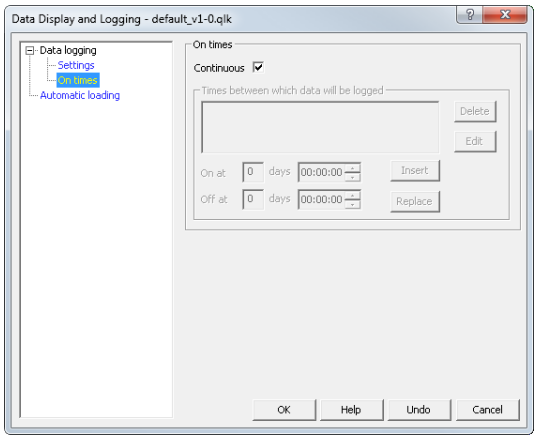

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Specify the logging rate and destination file name and location using **Data logging-Settings**:

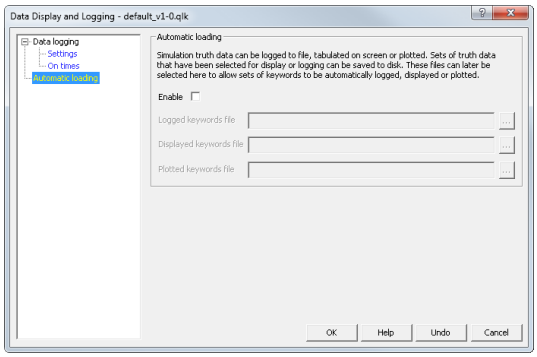
- Select **Enable** to enable data logging
- Type the **Logging rate**. You must select a multiple of the rate you select in menu item **Options-*General Options*-Simulation iteration rate** (page 5-15).
  For example, using a Simulation Iteration Rate of 10 milliseconds the maximum logging rate is 10 milliseconds, but other valid rates are 20, 30, 40 milliseconds and so on
- The default storage folder is the current scenario folder

Specify **On times** using **Data logging-On times**. This allows logging of large amounts of data at a high-rate, so conserving disk space. The default is **Continuous** logging.




Deselect **Continuous** and enter the on and off days and times of day you want the data to be logged.

You can specify sets of data for automatic logging, automatic display or for automatic plotting of sets of keywords using **Data logging-Automatic loading**.




Select **Enable** to enable automatic loading. Then navigate to, and select, the files you want to load automatically. This table details the keyword files

| Keyword file | File extension | See section |
|---|---|---|
| **Logged keywords file** | **.qll* | ***Log data to a file*** (page 25-10) |



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| Keyword file | File extension | See section |
|---|---|---|
| **Displayed keywords file** | **.qld* | ***Displaying run-time data*** (page 25-13) |
| **Plotted keywords file** | **.qlp* | ***Plotting data versus time*** (page 25-14) |


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# 26 SimGEN utilities

Spirent provides a number of utilities with SimGEN. Some utilities apply to specific signal generator models, for example, calibration utilities, whereas other utilities apply to any signal generator. This table shows the SimGEN utilities available in the **Tools** menu.

| Tools menu item |
|---|
| ***4500 / 6560 / 5060 / 4150 Utilities*** |
| ***6700 utilities*** (page 26-7) |
| ***4750 / 60 / 80 / 90 Utilities*** (page 26-7) |
| ***7xxx and 8xxx Utilities*** (page 26-21) |
| ***7xxx/9xxx*** Utilities (page 26-21) |
| ***General Utilities*** (page 26-31) |

This table gives details on stand-alone utilities. You cannot access stand-alone utilities directly from SimGEN, the relevant section gives the location of the utility executable.

| Utility |
|---|
| ***Binary to ASCII file conversion utility*** (page 26-61) |
| ***SBAS FEC file generator utility*** (page 26-62) |

## 26.1 4500 / 6560 / 5060 / 4150 Utilities

This table shows the SimGEN utilities available in the menu item **Tools-*4500 / 6560 / 5060 / 4150 Utilities***.

| 4500 / 6560 / 5060 / 4150 Utilities |
|---|
| ***Annual Calibration*** |
| ***USB String Send*** |
| ***Single Channel Utility*** (page 26-2) |

### 26.1.1 Annual Calibration

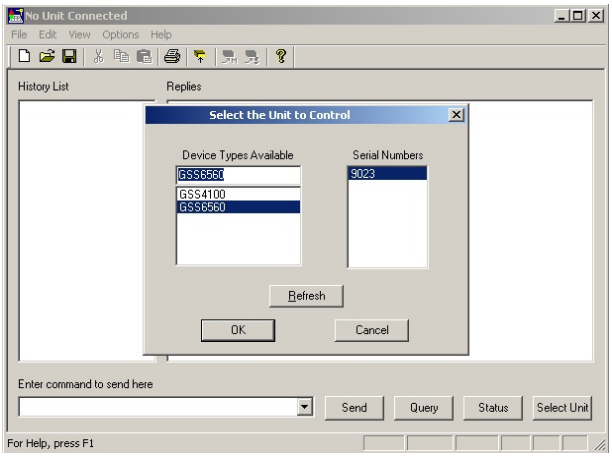
See reference mm) for full details of calibrating the superseded GSS6560 and GSS5060 signal generators.

### 26.1.2 USB String Send

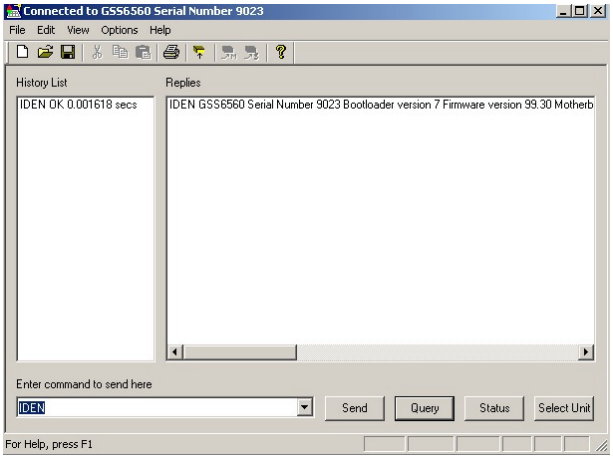
The **USB String Send** utility allows interactive control over USB of the superseded GSS6560 and GSS5060 signal generators. It can be a useful diagnostic tool to check signal generator operation as well as driving the signal generator as an interactive single channel signal generator.

When you run this utility, you must first choose the USB device to communicate with:


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This figure shows the **USB string send** dialog.




To use **USB string send**:

- → Select the command to send in the Enter command to send here text box, or type the command in the text box
- → Click on **Send** or **Query** to execute the command
- → The **Replies** area shows each command you send and the response to this command
- → The **History List** displays a history of previous commands
- → Click **Status** to get the status of the signal generator
- → Click **Select Unit** to select a different signal generator on the USB bus

### 26.1.3 Single Channel Utility (small chassis signal generators)

***Notes**:*

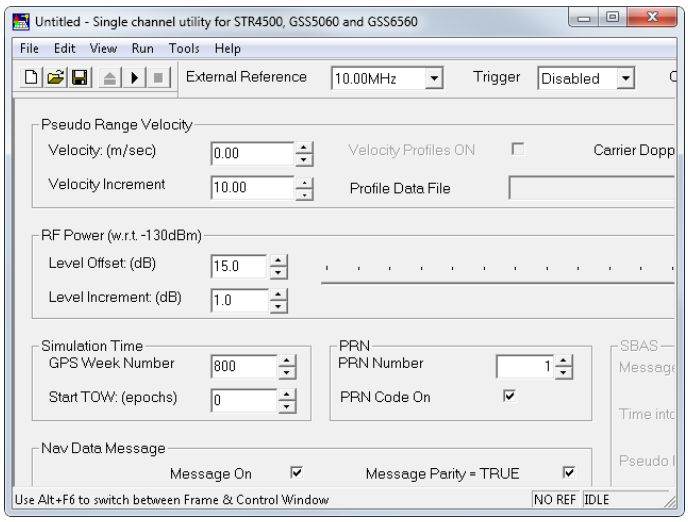
***1)** The* SBAS *area is disabled.*

***2)** Using Hot keys and keystrokes to open Menu items are only effective when the Single Channel Utility is active, as shown by a highlighted title bar. Press Alt+F6 to toggle the utility into the active state.*

The **Single Channel utility** allows you to use one channel (in an instrument mode) of the superseded GSS6560 and GSS5060 signal generators as a simple satellite signal source. You can control the PRN code, Navigation data message, signal level, Doppler and other characteristics using this Utility. The figure below shows the interface.

The **Single Channel Utility** also offers advanced control using simple script files.


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| | | | |
|---|---|---|---|
| **External Reference** | Choose from: **1.00 MHz**, **5.00 MHz**, **10.00 MHz** (default) | | |
| **Trigger** | Choose from: **Disabled** (default), **Immediate**, **Delayed** | | |
| **Constellation** | Choose from: **GPS, Galileo** | | |
| **Pseudo Range Velocity** | Rate of change of simulated Pseudo Range | | |
| **Velocity (m/sec)** | Units: metres per second | Range: -15 0000.00 to +15 000.00 $m.s^{-1}$ | Default: 0.00 |
| **Velocity increment** | Units: metres per second | Range: 0.01 to 5 000.00 $m.s^{-1}$ (in 1, 2, 5 steps) | Default: 10.00 |
| ***Note**: Each time you click on the Up or Down arrow to the right of the **Velocity** text box, the value shown in the **Velocity Increment** text box will be added, or subtracted, to the **Pseudo Range Velocity*** | | | |
| **Velocity Profiles ON** | Deselect (default): Does not use a Velocity profile<br>Select: Use one of the **Profile Data Files**. | | |
| **Carrier Doppler Offset** | Simulate Ionospheric delay effects by applying a fixed Doppler velocity offset to the current carrier Doppler velocity. The code Doppler velocity remains unchanged. | | |
| | Units: metres per second | Range: -1 000.00 to +1 000.00 $m.s^{-1}$ | Default: 0.00 |
| **RF Power (w.r.t. −130 dBm)** | Sets the RF power output | | |
| **Level offset (dB)** | Use the Up / Down arrows to increment and decrement **Level Offset (dB)** by the value you enter in **Level Increment**, or use the slider to force the **Level Offset (dB)** to a multiple of the **Level Increment**.<br>To avoid discontinuities at the range limits when using a user-defined Level Increment, the nearest pre-defined Level Increment value is used, rather than the value you enter. | | |
| | Units: decibel (relative to -130 dBm) | Range: -20.0 to +15.0 dB | Default: 15.0 |
| **Level increment (dB)** | Type any value, including values greater than the RF Power Level range of 35.0 dB or use the pre-defined values below. | | |
| | Units: decibel | Pre-defined: 0.1 to 5.0 dB (in 1, 2, 5 steps) | Default:1.0 |
| **Simulation Time** | | | |


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| | | | |
|---|---|---|---|
| **GPS Week Number** | You cannot define GPS Week Number, which depends on the Navigation Message type you select. GPS Week Number 682 is set for Navigation Message type 1 and GPS Week Number 1 is set for Message type 2 | | |
| **Start TOW (epochs)** | The Time-of-Week expressed in GPS Epochs that will apply at the start of the simulation. During a simulation, **Start TOW** shows the current Time-of-Week. | | |
| | Units: GPS epoch (1.5 seconds) | Range: 0 to 403196 (in steps of 4) GPS Epochs) | Default: 0 |
| **PRN** | The Pseudo Random Noise (PRN) Number defines the identity for each simulated satellite. It is the same as the SVID, except for GPS satellites using the ***Extended GPS constellation*** (page 10-2). | | |
| **PRN number** | Units: none | Range: 1 to 37 | Default:1 |
| **PRN Code On** | Select (default): generate PRN code<br>Deselect: do not generate PRN code | | |
| **Nav Data Message** | | | |
| **Message On** | Select (default): generate Nav Data Message<br>Deselect: do not generate Nav Data Message | | |
| **Message Parity = TRUE** | Select (default): no parity errors<br>Deselect: inverts each parity bit to introduce parity errors | | |
| **Message File** | Choose the message file from the drop-down list | | |
| ***Note**: Signal generator hardware buffers the data message. If you change the parity status while the signal generator is running, there will be a delay before the RF output reflects the change.*<br>*Spirent recommends you set-up this feature while the **Single Channel Utility** is idle and the signal generator is not operating.* | | | |

Set the **Arm**, **Run** and **Halt** actions using one of:

- → The Run menu
- → The Toolbar
- → The Hot keys: Ctrl+A (Arm), Ctrl+R (Run) and Ctrl+H (Halt)

### 26.1.3.1 Toolbar

This table details the Single Channel utility toolbar.

| Button | Command | Description |
|---|---|---|
|  | **New** | Closes any open parameters file<br>Resets the parameters. |
|  | **Open** | The Windows **Open file** dialog |
|  | **Save** | Saves the current parameters to a file or prompts for a new file name. |
|  | **Arm** | Click to load the simulation parameters and prepare for a run.<br>The Status bar shows ‘Ready to Run’ when the arming sequence is complete. |
|  | **Start** | Click to release the superseded GSS6560/5060 to begin the simulation.<br>You must click **Start** to start the simulation.<br>To return to the idle state without running the simulation, click **Halt**. |
|  | **Halt** | Click to abort the simulation in progress or to terminate the Arm command (“Ready to Run” state) and return to the Idle state. |


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#### 26.1.3.2 Prompts, warnings and errors

***Note**: The utility automatically removes old messages and it is not normally necessary to clear old messages.*

The **Single Channel Utility** displays single line text messages in the text box towards the bottom of the window, these messages describe events that occur during execution of the program.




The text box shows the latest message. The Single Channel Utility stores previous messages in time sequence. You can view previous messages by clicking the Down arrow.

Click **Clear** to clear all messages.

### 26.1.4 Editing the nav data file

SimGEN stores the nav data message in an ASCII text file. You can create this file or edit an existing one, using a text editor such as Windows Notepad. The following description details the default GPS navigation message.

The navigation message uses 25 frames of data and has a total duration of 12.5 minutes. Each frame consists of five subframes, which in turn consist of ten, thirty-bit words.

For words 3 through 10 of each subframe, you can use stored data to generate representative navigation data. You can select the parity bits of these words to be valid or invalid.

The format of the telemetry and handover words (words 1 and 2) does not change. The parity bits for these words are always valid.

SimGEN calculates parity bits following reference a). Where shown, parity bits are always the transmitted parity bits. The other data bits (1-24) are source data bits, which may be inverted before transmission depending on the calculated parity bit 30 (transmitted) of the previous word. The source data bits of the words 1 and 3 of every subframe are never inverted before transmission, because bit 30 of the previous word is always zero for these words. The data/parity bits marked '*' may vary from frame to frame and are calculated before transmission.

The **Single Channel Utility** encodes Time-of-Week and GPS Week into the transmitted message while running. The **Single Channel Utility** supports Week number rollovers, but does not support ephemeris cut-overs, and it automatically calculates Satellite health data in the navigation message to reflect the selected PRN Number.

Nav data file parameters:

- Comments - denoted by an exclamation mark (!) in the first column.
- Line length - must not exceed 24 characters.
- Total number of lines - must not exceed 549.
- An entry in the single channel utility interface overrides the TOW and week number fields in the nav data message.
- You cannot define Subframe ID (word2).
- The almanac health fields for the SVID are always set healthy in page ID 51 or 63, as appropriate.

#### 26.1.4.1 Data Fields

The data is organised by word and subframe with this order:

- word 1 for all subframes
- word 2 for all subframes
- words 3 through 10 for subframes 1 through 3
- words 3 through 10 for Page ID 1 through 32 and 51 through 63

Reference a) defines each Page ID, which specifies the contents of subframes 4 and 5. Page ID 57 is used four times, 62 used twice.

A comment after each line of data defines the word number.

A typical line is:


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```
8BAAAB tttttt wd 1
```

The first six characters (8BAAAB) represent the 24-bit word data in hexadecimal format:

| | | | | | |
|---|---|---|---|---|---|
| 8 | B | A | A | A | B |
| 1000 | 1011 | 1010 | 1010 | 1010 | 1011 |

The bit order is leftmost transmitted first.

The next six characters are reserved for future implementation of parity adjustment, do not change from tttttt.

The next character is a space delimiter.

The remaining characters are comments, in this case showing word 1 for all subframes (the telemetry word).

#### 26.1.4.2 Example file

```
!no.lines in file <550
!line length <25 chars
!
!bit 1 on left
!bit 24 on right
!wds 1&2 every sframe
8BAAAB tttttt wd1
000000 tttttt wd2
!
!subframes 1 to 3
!
!subframe1
002200 tttttt wd3
AAAAAA tttttt wd4
AAAAAA tttttt wd5
AAAAAA tttttt wd6
AAAA04 tttttt wd7
0501C2 tttttt wd8
060007 tttttt wd9
000020 tttttt wd10
!
!subframe2
!
050009 tttttt wd3
000A00 tttttt wd4
00000B tttttt wd5
000C00 tttttt wd6
00000D tttttt wd7
000EA1 tttttt wd8
0D999A tttttt wd9
01C2A8 tttttt wd10
!
!subframe3
!
000F00 tttttt wd3
000010 tttttt wd4
001126 tttttt wd5
6669B8 tttttt wd6
001240 tttttt wd7
000000 tttttt wd8
000013 tttttt wd9
050050 tttttt wd10
!
!subframes 4 & 5
!pages 1 to 25
!
!page id1
!
410000 tttttt wd3
020000 tttttt wd4
0001FF tttttt wd5
A10D9A tttttt wd6
000000 tttttt wd7
400000 tttttt wd8
05E51E tttttt wd9
```


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```
000000 tttttt wd10
!
!page id2
!
420000 tttttt wd3
020000 tttttt wd4
0001FF tttttt wd5
A10D9A tttttt wd6
000000 tttttt wd7
400000 tttttt wd8
05E51E tttttt wd9
000000 tttttt wd10
!
! <page id's 3 to 32 and page id's 51 to 63 removed>
```

## 26.2 6700 utilities

Reference xx) details the GSS6700 utilities. ***USB String Send*** (page 26-1) describes the USB String Send utility.

## 26.3 4750 / 60 / 80 / 90 Utilities

***Note**: GSS8000-series signal generators use IP to communicate with the SimGEN Controller. Other signal generators use the IEEE-488 bus. All relevant utilities automatically determine the correct communication protocol to use.*

This table shows the SimGEN utilities available in the menu item **Tools-*4750 / 60 / 80 / 90 Utilities***.

| **4750 / 60 / 80 / 90 Utilities** |
|---|
| ***IEEE-488 or IP String Send Utility*** (page 26-7) |
| ***Channel Alignment*** (page 26-10) |
| ***DACT Power Level Cal and NVRAM backup*** (page 26-14) |
| ***Single Channel Utility*** (page 26-14) |

### 26.3.1 IEEE-488 or IP String Send Utility

***Notes**:*

***1)** From SimGEN version 1-08 on, you can use the **String Send** utility to control SimGEN using the IEEE-488 bus and the SimREMOTE command set in reference qq).*

***2)** From SimGEN version 2-72SR04 on, you can use the **String Send** utility to control SimGEN using IP and the SimREMOTE command set see reference qq).*

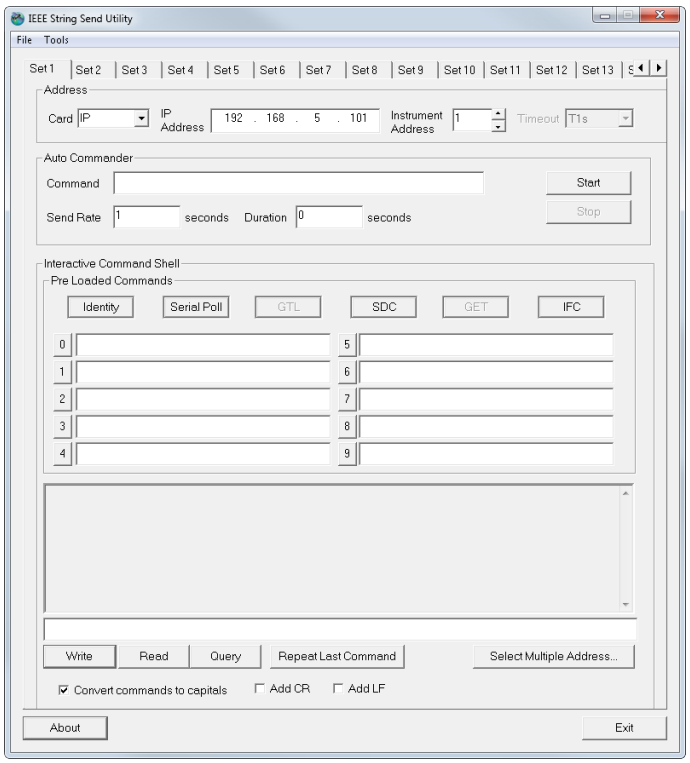
**3)** *Pre-Loaded Commands **GTL** and **GET** are only available under the IEEE-488 protocol and are not available under the IP protocol.*

***4)** The IP string send utility detects whether a SimGEN controller (GSS8000-series, and earlier, signal generator), a C50r SimGEN Host (GSS9000-series signal generator) or an Embedded Host (GSS7000 signal generator) is in use and applies the correct IP address:*
*127.0.0.1 for GSS8000-series, and earlier, signal generators*
*192.168.25.1 for GSS9000-series and GSS7000 signal generators*

***5)** After changing the signal generator configuration in a simulator consisting of multiple GSS8000-series (or earlier) signal generators, Spirent recommends you use the **IEEE string send** utility to send to each signal generator a series of **SDC** messages.*
*You must wait for each signal generator to report its status before sending the next **SDC** message.*
*Before you stop sending **SDC** messages to a signal generator, you must wait for it to report its status as good.*
*Each signal generator in your simulator must report its status as good before you start a new run.*

The **String Send** utility allows interactive control of GSS9000-series, GSS7000 and GSS8000-series signal generators using IP; or GSS77xx/78xx, STR4760/80 or STR4790 signal generators over an IEEE-488 bus.


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The **String Send** utility is a useful diagnostic tool to check signal generator operation. It can control the signal generator as an interactive, single channel signal generator.

If your signal generator uses IP, first see ***Map the base IP Address*** (page 26-8)

If your signal generator uses the IEEE-488 bus, first see ***Select the IEEE-488 Address*** (page 26-9)

Now see ***Using the utility*** (page 26-9)

### 26.3.1.1 Map the base IP Address

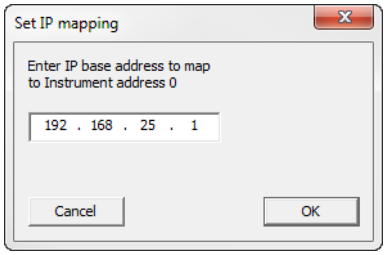
***Notes**:*

***1)** Spirent set the base IP address before shipping you signal generator. Contact Spirent Global Services before changing base address.*

***2)** Only applicable to signal generators with an IP address*

***3)** You must use IP address 192.168.25.1 for GSS9000-series signal generators using the C50r SimGEN Host, or GSS7000 signal generators using an Embedded Host*

This maps the “base” IP address of your signal generator to **Instrument Address 0**. Click on **Tools-Set IP mapping...** to open the **Set IP mapping** dialog:




Type the IP base address that you want to map to **Instrument Address 0** in the text box. The maximum **Instrument address** is 30.

Click **OK**.

Click on the up / down arrows to the right of the **Instrument Address** text box until the IP address of your signal generator appears in the **IP Address** text box.


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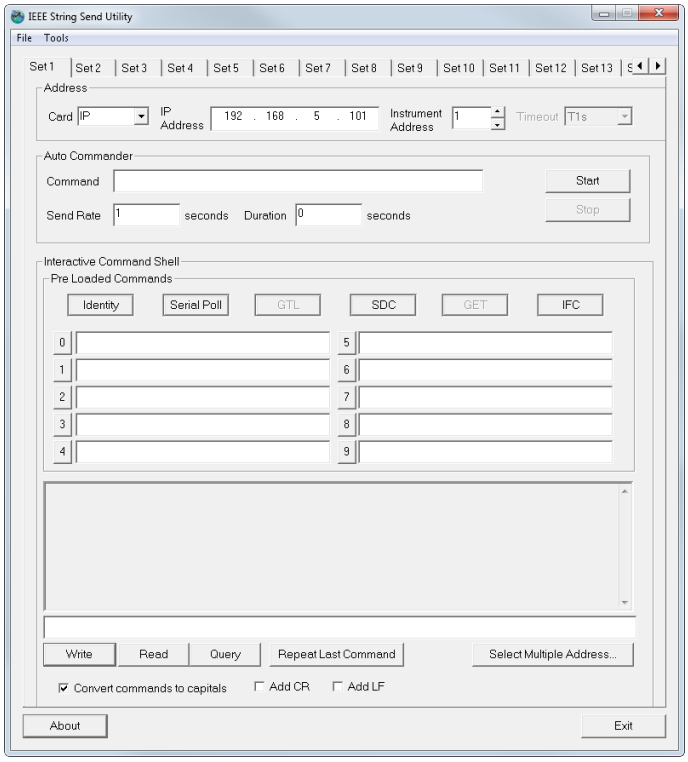
### 26.3.1.2 Select the IEEE-488 Address

***Note**: Only applicable to signal generators using the IEEE-488 bus*

Click on the up / down arrows to the right of the **Instrument Address** text box to select the IEEE-488 bus address of your signal generator. The maximum **Instrument Address** is 30.

### 26.3.1.3 Using the utility

The utility dialog has fifteen tabs at the top of the dialog. Each tab gives an identical screen that you can use to send commands to your signal generator:




This table details the main areas of the dialog.

| Area | Description |
|---|---|
| **GPIB** | For signal generators using the IEEE-488 bus enter the GPIB card number and Timeout of your signal generator, then select its **Instrument Address**<br>For signal generators using IP select the **IP Address** |
| **Auto commander** | Define the **Command**, its **Send rate** and **Duration** |
| **Interactive Command Shell** | The following table details the buttons for the Pre-Loaded Commands.<br>***Note**: The IP protocol does not support all Pre-Loaded Commands.*<br>Beneath these buttons is the history of the last 10 commands. You can resend a command by pressing the corresponding key on the keyboard number pad. |
| Under history buttons | This area shows the response from the signal generator. Click in the text box beneath the response area for the signal generator and type the command string.<br>Click on the buttons below this area to execute the command string |

This table shows the pre-loaded commands.

| Button | Description |
|---|---|
| **SDC** | Sends Selective Device Clear to the device at the current Address |
| **GET** | Sends Group Execute Trigger to the device at the current Address<br>***Note**: **GET** is only available using the IEEE-488 bus* |


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| Button | Description |
|---|---|
| **IFC** | Momentarily sets the Interface Clear bus control line |
| **GTL** | Sends Go To Local command<br>***Note**: **GTL** is only available using the IEEE-488 bus* |

## 26.3.2 Channel Alignment

***Note**:*

***1)** Spirent recommends you perform this calibration each time you power cycle your signal generator, or if there has been a significant change in temperature of the signal generator since its last calibration.*

***2)** Spirent recommends you perform this calibration at least 30 minutes after powering on the signal generator to allow its operating temperature to stabilise*

The **Channel Alignment** utility performs a calibration procedure to maintain the optimum performance of your signal generator.

### 26.3.2.1 STR4760/80/90 and GSS4750/77xx/78xx signal generators

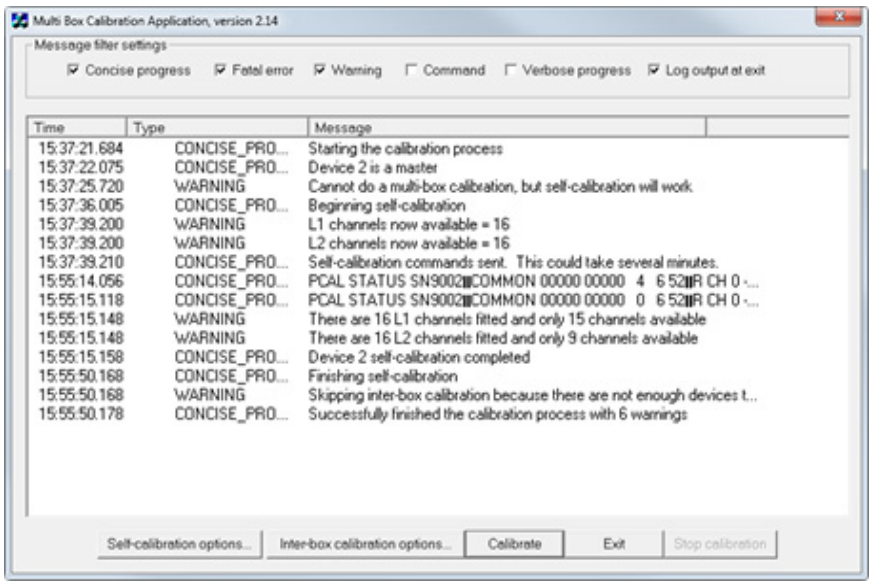
The figure below shows the **Channel Alignment** utility for systems using a single STR47xx or GSS77xx/78xx signal generator. This utility aligns the code and carrier phases of each signal generator channel. This is the **PCAL** process.

For systems with two or more signal generators (optionally connected using a GSS4767 Distribution Unit), this utility also aligns the channels between signal generators. This is the **Inter-Unit Calibration** process.

The central area of the dialog shows the calibration progress

Click **Calibrate** to start the calibration process.

The calibration process shows diagnostic output messages relating to current progress, errors, and results and so on, in real-time. The figure below shows typical messages after completion of a successful calibration of a system a single STR4760 system.




### 26.3.2.2 GSS8000 signal generators

This figure shows the **Channel Alignment** utility for a single GSS8000-series signal generator, which aligns the code and carrier phases of each signal generator channel. This is also known as the **PCAL** process.

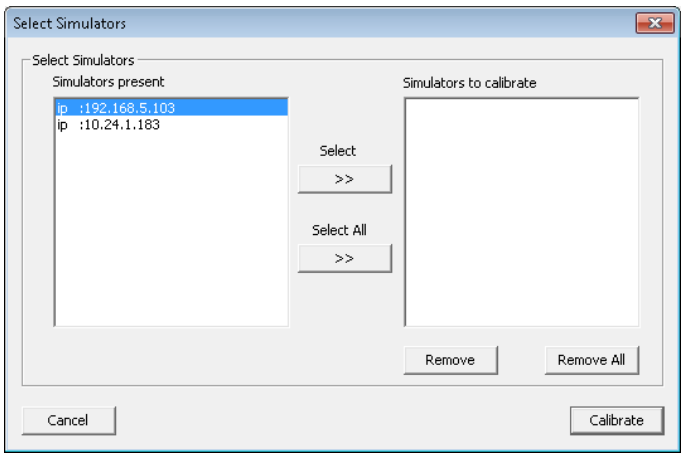
For systems with two or more signal generators, this utility also aligns the channels between signal generators. This is the **Inter-Unit Calibration** process.

The central area of the dialog shows the calibration progress.

Click **Calibrate**. For GSS8000-series signal generators the **Select Simulators** dialog, see figure below, appears.

***Note**: You will not see this dialog if your signal generator uses the IEEE-488 bus*


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The **Simulators present** area shows the IP addresses of all GSS8000-series signal generators connected to your network (with ac power switched on).

Highlight the signal generator you want to calibrate and click **Select**. Spirent recommends you calibrate all available signal generators by clicking **Select All**.

If you select a signal generator in error, highlight it and click **Remove**, or click **Remove All**.

Click **Calibrate** to begin calibrating your GSS8000. The calibration process shows diagnostic output messages relating to current progress, errors, and results and so on, in real-time. The figure above showing the **Channel Alignment** utility shows typical messages from the calibration of a single GSS8000.

### 26.3.2.3 Message filter

This table shows the **Message filter settings**.

| Message filter | Displays |
|---|---|
| Concise progress | Important parts of the calibration and important data values set or changed |
| Fatal error | An error has occurred that means the calibrations cannot continue |
| Warning | An error has occurred but the calibrations can continue although 4760 performance may be degraded |
| Command | IEEE-488 or IP commands being sent and the data received back |
| Verbose | Contains detailed information about the progress of the calibrations for debug purposes |

Select **Log file at exit** to log the messages you select to a file. The name of the log file has the format *interboxcal_yyyy_mm_dd_hh_mm_ss.txt*. This table details the dump files the utility automatically generates – these files are overwritten every time the utility runs.

| Filename | Messages the file contains |
|---|---|
| *all_message_dump.txt* | SimGEN dumps all messages in this file, just as if you selected all **Message file settings**. |
| *command_dump.txt* | Just the commands sent to the devices and the replies received back. |
| *concise_message_dump.txt* | Saves just the concise messages to the text file |

### 26.3.2.4 Phase calibration

***Notes**:*

***1)** Do not perform a phase calibration more than once a week due to stability and time taken to complete. The reproducibility of the auto-cal process may be comparable, or even worse, than the short-term drift in the signal generator.*

***2)** Do not perform an auto-cal between each test in a sequence. This is unlikely to improve accuracy and introduces another unknown when you compare run-to-run results. This effect is of the order of centimetres for pseudorange and sub-millimetre for carrier phase.*


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Spirent recommends you perform a phase calibration on your signal generator:

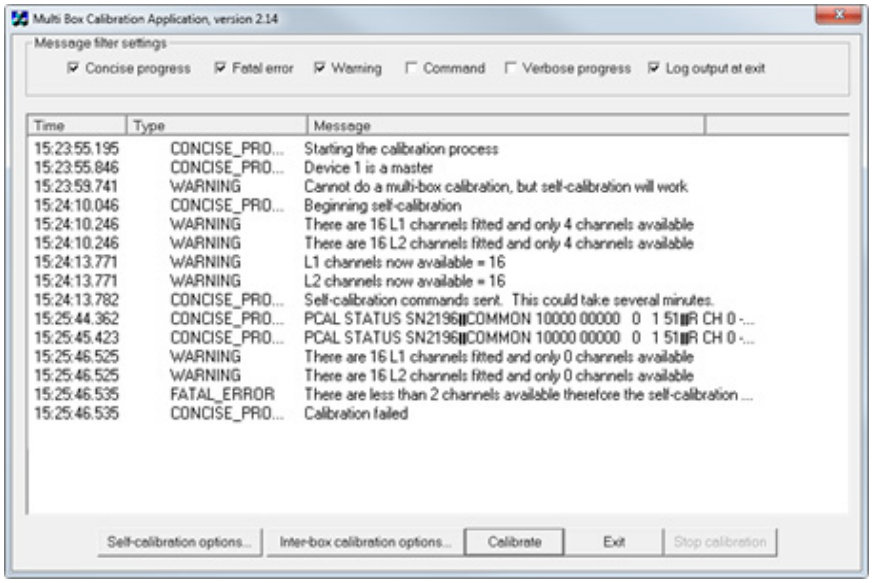
- When you first turn on ac power
- If you move it or transport it to a different area
- If there is a significant temperature change
- If you reconfigure it (such as when a dual-system is split into single signal generators)
- Performing a phase calibration each week is good practice.

### 26.3.2.5 Phase calibration warnings and failures

Some channels within a signal generator failing calibration result in the message PCAL WARNING. SimGEN hides these faulty channels so you cannot use them. You may be able to continue using your signal generator Spirent recommends you contact Spirent Global Services.

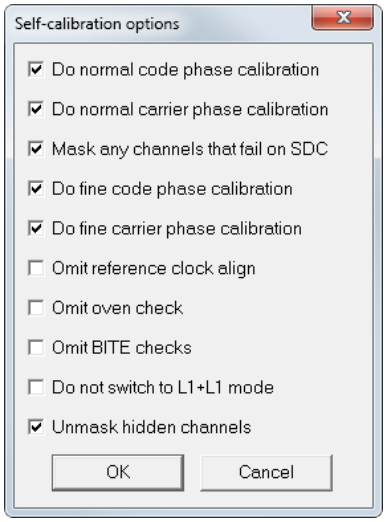
All channels within a signal generator failing to calibrate result in the message PCAL FAILED. SimGEN hides all the channels and you can no longer use your signal generator. Contact Spirent Global Services for assistance.

This figure shows an example calibration failure.




### 26.3.2.6 Self-calibration options

You can set calibration options from the **Self-calibration options** dialog:




This table details the self-calibration options:


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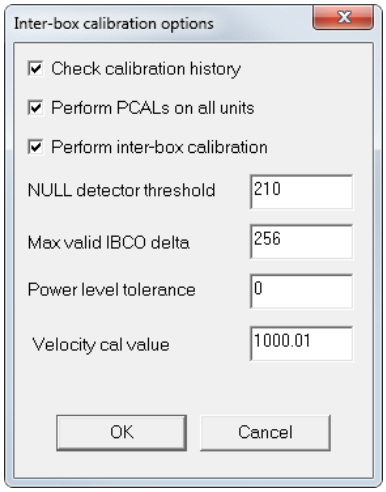
| Calibration Option | Effect |
|---|---|
| **Do normal code phase calibration** | Aligns the code phases for each channel |
| **Do normal carrier calibration** | Aligns the carriers of each channel |
| **Mask any channels that fail on SDC** | Masks any channels that fail when the device has finished calibrating |
| **Do fine code phase calibration** | Aligns the code phases more finely |
| **Do fine carrier calibration** | Aligns the carrier phases more finely |
| **Omit reference clock align** | Do not do the reference clock align |
| **Omit oven check** | Do not do the oven check test |
| **Omit BITE checks** | Do not do any BITE tests |
| **Do not switch to L1+L1 mode** | Do not switch to L1+L1 mode after the calibrations have finished |
| **Unmask hidden channels** | Displays channels hidden during previous calibrations, before the calibration (PCAL process) begins. Select for normal operation. Deselect if the system has known faulty channels. This will allow calibration excluding the faulty channels. |

***Note**: Perform at least one calibration to determine the faulty channel(s). This will hide the channels. You can then perform a subsequent calibration excluding the faulty channel(s).*

### 26.3.2.7 Inter-box calibration options

***Note**: Do not change any of these options unless instructed by Spirent.*

Unless instructed by Spirent personnel, always use the default values:




This table describes the calibration options

| Calibration option | Effect |
|---|---|
| **Check calibration history** | Select: Uses the current IBCO value as the starting point for the calibration.<br>Deselect: Resets the IBCO value to 0<br>***Note**: By default, the inter-box calibration process keeps a history of previous calibration data. If the calibration result changes from the previous run by the value set in Max valid IBCO delta, an IBCO HISTORY WARNING message is shown* |


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| Calibration option | Effect |
|---|---|
| **Perform PCAL on all units** | Select to perform self-calibration on all signal generators |
| **Perform inter-box calibration** | Select to perform Inter-box calibrations on all signal generators |
| **NULL detector threshold** | Range 0 to 256.<br>When any part of the inter-box calibration finishes and the power level is above this threshold, a fatal error will occur |
| **Max valid IBCO delta** | See “Check calibration history” |
| **Power level tolerance** | For Spirent use only |
| **Velocity cal value** | For Spirent use only |

#### 26.3.2.8 Maintaining phase calibration status

***Note**: Spirent recommends running the phase calibration procedure regularly. It verifies correct operation of most of the system and maintains optimum system performance.*

After a power cycle, perform a phase calibration on all systems that include one or more STRxx or GSS47/77xx/78xx signal generators.

If you have not changed the rear-panel cables, all single signal generator STRxx and GSS47/77xx/78xx systems maintain phase calibration status after a power cycle.

If you have not changed the rear-panel cables AND you observe the correct power up sequence, systems including multiple STR47xx and GSS47/77xx/78xx signal generators can maintain phase calibration status after a power cycle.

Powering on all signal generators at the same time maintains the phase calibration status. Alternatively, use the following sequence to power up the signal generators:

- → Turn on all STR4767 Distribution units (if present)
- → Turn on the Master signal generator
- → Turn on the Auxiliary signal generators

### 26.3.3 DACT Power Level Cal and NVRAM backup

***Note**: You do not need to use the DACT program to calibrate GSS77xx, GSS78xx and GSS8000-series signal generators.*

Reference mm) details the Customer Calibration Procedures for Spirent signal generators.

### 26.3.4 Single Channel Utility - SimCHAN20 (large chassis signal generators)

***Notes**:*

***1)** SimCHAN20 detects GSS77xx signal generators when they are set to L1:L2 configuration.*

***2)** SimCHAN20 detects GSS78xx signal generators when they are set to E5:E6:L1 configuration.*

***3)** Navigation data messages are not available in the GSS78xx firmware. Not supported for SimCHAN20’s Galileo interface.*

***4)** With GSS7xxx signal generators using firmware up to version 1.12, SimCHAN20 provides 10 dB more output power than SimGEN, see the table below.*

***5)** Spirent supplies C/NAV symbol files only to authorised Galileo users*

***6)** The Single Channel Utility supports Galileo Open Service users.*

***7)** Currently, the Single Channel Utility uses Galileo L1, rather than Galileo E1*

***8)** Authorised Galileo users must insert the dongle Spirent supplies into a USB port on the SimGEN Controller to enable their authorised Galileo features.*

***9)** Currently, the Single Channel Utility does not support Galileo CBOC.*

***10)** Currently, the Single Channel Utility does not support GPS L1C.*


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SimCHAN20 lets you set and adjust the operating parameters of a single satellite channel in real-time and displays the responses.

This section refers to the Single Channel Utility for large chassis signal generators, also known as SimCHAN20. SimCHAN20 shares some common features with, but is not identical to the ***Single Channel Utility (small chassis signal generators)*** (page 26-2). Depending on your signal generator, SimCHAN20 lets you control GPS or Galileo signal generators. This utility uses hardware settings similar to those in SimGEN, see the menu item **Options-*Hardware*** Configuration (page 5-18) and this table:

| Constellation (software) | ICD reference power, dBm | SimCHAN power range, dBm (see Note 4 above) | | |
|---|---|---|---|---|
| | | -30 | 0 | +20 |
| Galileo (SimCHAN20) | -122 (E1 / E6 A, B, C components in place) | -152 | -122 | -102 |
| GPS (SimCHAN20 and SimGEN) | -130 (L1, C/A code) | -160 | -130 | -110 |
| GPS (SimCHAN20 with GSS7xxx up to firmware 1.12, see Note 4) | -130 (L1, C/A code) | -150 | -120 | -100 |

SimCHAN20 will detect all available signal generators over IP or on the IEEE-488 bus and will prompt you to choose the signal generator(s) you want to control. You can control up to two independent signal generators in parallel, using one of the following signal generator combinations:

- A sole GSS8000-series, or the superseded GSS77xx, GSS78xx or STR47xx, signal generator
- A combination of GSS8000-series and the superseded GSS78xx, GSS77xx or STRxx signal generators (you must assign each signal generator a unique IEEE-488 address using the IEEE-488 bus)

If you choose a signal generator(s) that is unavailable, use the menu item **Options-Select Simulator** to re-scan for available signal generators and re-select the signal generator you want to use.

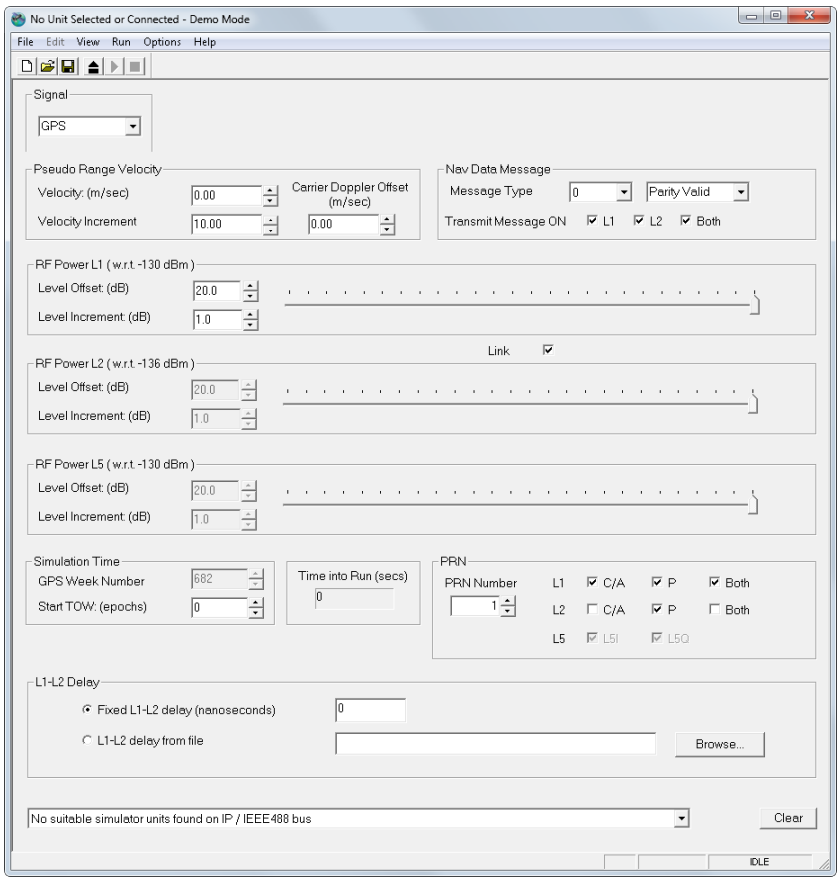
When controlling both GPS and Galileo signal generators, use **Signal** to select the relevant signal and set-up each signal generator. For single signal generator configurations, set **Signal** to the appropriate signal generator type.


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### 26.3.4.1 SimCHAN20 parameters for GPS

This figure shows SimCHAN20 controlling a GPS-capable signal generator.

***Note**: The reference power shown in brackets is the ICD reference power - see **Note 4)** at the start of **Single Channel Utility - SimCHAN20 (large chassis signal generators)** (page 26-14)*




| | | | |
|---|---|---|---|
| **Signal** | Select: **GPS** | | |
| **Pseudo Range Velocity** | Define pseudorange parameters using: | | |
| **Velocity (m/sec)** | Use the Up / Down arrows to increment and decrement Velocity by the value you enter in Velocity Increment, | | |
| | Units: metres per second | Range: -15 000.00 to +15 000.00 $m.s^{-1}$ | Default: 0.00 |
| **Velocity Increment** | Units: metres per second | Range: 0.01 to 5 000.00 $m.s^{-1}$ (in 1, 2, 5 steps) | Default: 10.00 |
| **Carrier Doppler Offset** | Applies a fixed Doppler velocity offset to the current carrier Doppler velocity to simulate Ionospheric delay effects. The code Doppler velocity remains unchanged. | | |
| | Units: metres per second | Range: -1 000.00 to +1 000.00 $m.s^{-1}$ | Default: 0.00 |
| **Nav Data Message** | Set the contents of the nav data message | | |
| **Message Type** | Choose from: **Message type**: **0** (default) or **1** ;and **Parity Valid** (default) or **Parity Invalid** | | |
| **Transmit message ON** | Select (default): Transmit nav data messages on **L1**, **L2**, **Both** Deselect: Does not transmit nav data messages on **L1**, **L2**, **Both** | | |


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| | | | |
|---|---|---|---|
| **RF Power** (carrier) | Sets the RF power output for each carrier, relative to the GPS reference level | | |
| **Level Offset (dB)** | Use the Up / Down arrows to increment and decrement RF Power by the value in **Level Increment**, or use the slider to force **Level Offset (dB)** to a multiple of the Level Increment.<br>If you define Level Increment, SimCHAN20 avoids discontinuities at RF Power limits by using the nearest pre-defined Level Increment. | | |
| | Units: decibel | Range: -30.0 to +20.0 dB | Default: 20.0 |
| **Level Increment (dB)** | Type a value, including values greater than the RF Power Level range (50.0 dB), or use the pre-defined values below. | | |
| | Units: decibel | Pre-defined: 0.1<br>to 5.0 dB<br>(in 1, 2, 5 steps) | Default:1.0 |
| **Link** | Select (default): Links all sliders<br>Deselect: Gives separate control for each slider | | |
| **Simulation time** | Displays time information | | |
| **GPS Week Number** | Shows the GPS week number | | |
| **Start TOW (epochs)** | Time-of-Week expressed in GPS Epochs (1.5 seconds) that will apply at the start of the simulation.<br>Shows the current Time-of-Week during a simulation. | | |
| | Units: GPS epoch | Range: 0 to 403 196<br>(steps of 4) | Default: 0 |
| **Time into run (secs)** | Shows the time into run in seconds | | |
| **PRN** | Set the PRN parameters using: | | |
| ***Note**: SimGEN always sets GPS L5 PRN codes ON* | | | |
| **PRN Number** | Select the PRN code you want to use | | |
| | Units: none | Range: 1 to 37 | Default:1 |
| ***Note**: After you deselect all codes, the signal generator produces a CW output power that has the same level as the previous state with one code, or both codes, selected.* | | | |
| **Defaults for all PRN** | L1 C/A: selected | L1/P: selected | Both: selected |
| | L2C/A: deselected | L2/P : selected | Both: deselected |
| | Select either **C/A** OR **P** using the check boxes - you cannot select **C/A** AND **P** using their check boxes. If you want to use **C/A** AND **P,** you must select **Both**.<br>Deselecting **Both** deselects **C/A** AND **P**, then you can again select either **C/A** OR **P**, or select **Both** for **C/A** AND **P**. | | |
| **Delay** | Enter the delay between L1 and L2 | | |
| **Fixed L1-L2 delay** | Units: nanoseconds | Range: -120 to 240 ns | Default: 0 |
| **L1-L2 delay from file** | Click on **Browse** and navigate to the **.csv* format delay file you want to use | | |
| **Clear** | The text box to the left of **Clear** displays Error messages and Warnings.<br>Click to remove all the messages and warnings | | |

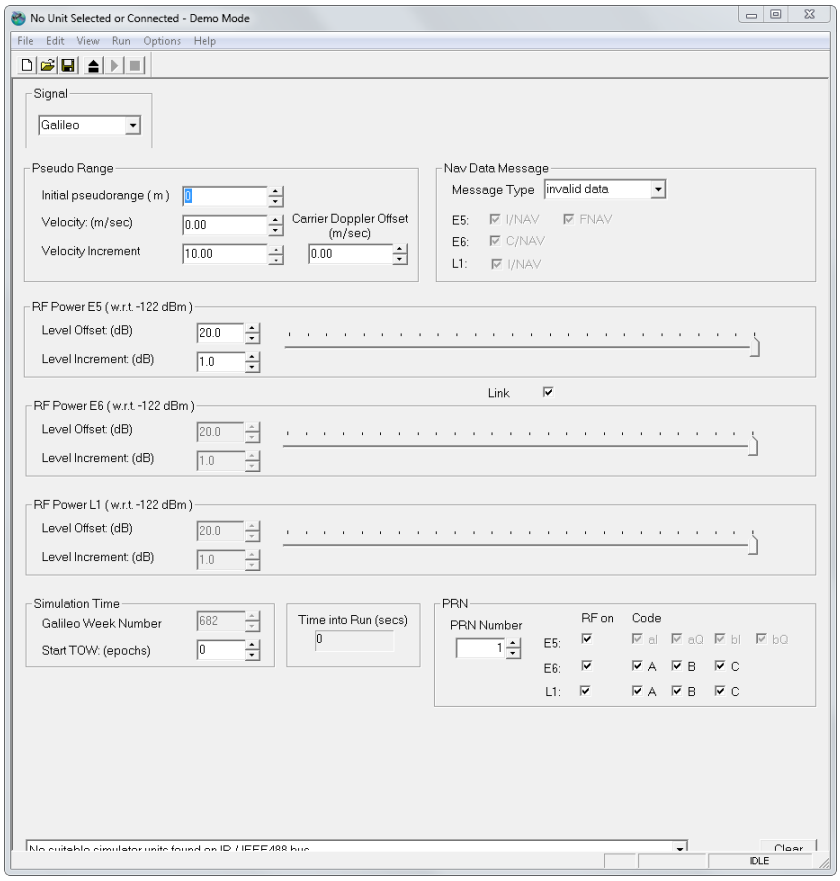

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### 26.3.4.2 SimCHAN20 parameters for Galileo

***Note**: Spirent supplies C/NAV symbol files only to authorised Galileo users*

This figure shows SimCHAN20 controlling a Galileo-capable signal generator.

***Note:** The reference power shown in brackets is the ICD reference power.*




| | | | |
|---|---|---|---|
| **Signal** | Set to Galileo | | |
| **Pseudo Range** | Define pseudorange parameters using: | | |
| **Initial pseudorange (m)** | Units: metres | Range: 0<br>to 29 979 246 m | Default: 0 |
| **Velocity (m/sec)** | Use the Up / Down arrows to increment and decrement Velocity by the value you enter in Velocity Increment, | | |
| | Units: metres per second | Range: -15 000.00<br>to +15 000.00 $m.s^{-1}$ | Default: 0.00 |
| **Velocity Increment** | Units: metres per second | Range: 0.01<br>to 5 000.00 $m.s^{-1}$<br>(in 1, 2, 5 steps) | Default: 10.00 |
| **Carrier Doppler Offset** | Applies a fixed Doppler velocity offset to the current carrier Doppler velocity to simulate Ionospheric delay effects.<br>The code Doppler velocity remains unchanged. | | |
| | Units: metres per second | Range: -1 000.00<br>to +1 000.00 $m.s^{-1}$ | Default: 0.00 |


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| | | | |
|---|---|---|---|
| **Nav Data Message** | Authorised users can use symbol files to generate the Galileo Nav Data Message. There are three symbol files (one each for C/NAV, I/NAV and F/NAV). During arming, SimCHAN20 loads one page of data for C/NAV, I/NAV and F/NAV and this repeats during a simulation. Symbol file names are:<br>*SC_gal_inav_symbol_data.dat*<br>*SC_gal_fnav_symbol_data.dat* and<br>*SC_gal_cnav_symbol_data.dat*<br>These files are located in the folder G*alileo_data_sets* | | |
| ***Note**: Spirent supplies C/NAV symbol files only to authorised Galileo users Unauthorised users can only use **Message type-invalid data*** | | | |
| **Message Type** | Choose from:<br>invalid data: turns off all data streams. You cannot individually select or deselect data streams, or:<br>symbols from file: to select each of E5 I/NAV and F/NAV, E6 C/NAV and L1 I/NAV. You cannot individually select or deselect these. | | |
| **RF Power** (carrier) | Sets the RF power output for each carrier, relative to the Galileo reference level | | |
| **Level Offset (dB)** | Use the Up / Down arrows to increment and decrement RF Power by the value in **Level Increment**, or use the slider to force **Level Offset (dB)** to a multiple of the **Level Increment**.<br>If you define Level Increment, SimCHAN20 avoids discontinuities at RF Power limits by using the nearest pre-defined Level Increment. | | |
| | Units: decibel | Range: -30.0 to +20.0 dB | Default: 20.0 |
| **Level Increment (dB)** | Type a value, including values greater than the RF Power Level range (50.0 dB), or use the pre-defined values below. | | |
| | Units: decibel | Range: 0.1 to 5.0 dB<br>(in 1, 2, 5 steps) | Default:1.0 |
| **Link** | Select (default): Links all three sliders<br>Deselect: Gives separate control for each slider | | |
| **Simulation time** | | | |
| **Galileo week Number** | Shows the Galileo week number | | |
| **Start TOW (epochs)** | Time-of-Week expressed in GPS Epochs (1.5 seconds) that will apply at the start of the simulation.<br>Shows the current Time-of-Week during a simulation. | | |
| | Units: GPS epoch | Range: 0 to 403 196<br>(steps of 4) | Default: 0 |
| **Time into run (secs)** | Shows the time into run in seconds | | |
| **PRN** | Set the PRN parameters and RF on / off using: | | |
| **PRN Number** | Select the PRN code you want to apply to the carriers shown | | |
| ***Note**: SimGEN always sets Galileo E5 PRN codes ON* | | | |
| | Units: none | Range: 1 to 50 | Default:1 |
| **Defaults for all PRN** | E6 A: selected | E6 B: selected | E6 C: selected |
| | E1 A: selected | E1 B : selected | E1 C: selected |
| **RF ON** | Select (default): turn RF on for that carrier<br>Deselect: turn RF off for that carrier | | |
| **Clear** | The text box to the left of the Clear button displays Error messages and Warnings. Click to remove all the messages and warnings | | |


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### 26.3.4.3 Run

***Notes**:*

***1)** This is an RS-232 remote command only*

***2)** Currently, this command is only enabled for Galileo satellites*

Use the **Run** menu to operate the signal generator using the toolbar buttons in this table, which also details the RS-232 commands:

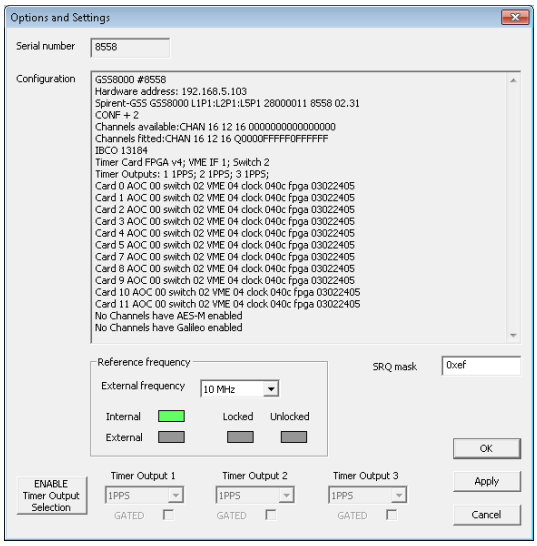
| Run command (RS-232 command) | Toolbar button | Description |
|---|---|---|
| Arm (AR) |  | Arms the simulation |
| Run (RU) |  | Runs the simulation |
| Halt (HALT) |  | Aborts a simulation in progress<br>Terminates the Arm command |
| (CARRIER) | none | Use to turn on / off the carrier and select individual frequencies.<br>The signal generator applies this command immediately after receiving it.<br><br>Command format - using the syntax in reference qq):<br><br>CARRIER, <on_off>,Galileo,<freq><br>Where:<br>on_off ::= “0” [| “off”] sets carrier off<br>| “1” [| “on”] sets carrier on<br>freq ::= “0” for E1<br>| “1” for E5<br>| “2” for E6<br>| “all” for E1 and E5 and E6 |

### 26.3.4.4 Options

Use the **Options** menu to set up your signal generator and RS-232 ports.

### 26.3.4.5 Hardware options

Use this dialog to display the hardware settings of your signal generator.




You can select the **External Trigger** and **External Frequency** reference from the drop-down lists.

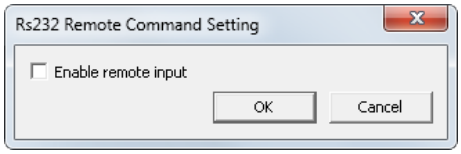

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#### 26.3.4.6 Select simulator

Use this to select the signal generator you want to use from all signal generators the utility detects on the IEEE-488 bus or on USB.

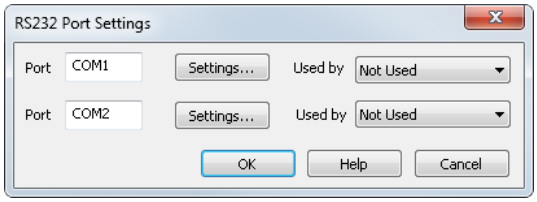
#### 26.3.4.7 RS232 Remote Command Setting

Use this dialog to enable the RS232 ports to accept remote input.




#### 26.3.4.8 RS232 Port Setting

Use this dialog to set up the RS-232 ports on the SimGEN Controller for control of SimCHAN20 from a remote PC.




## 26.4 7xxx and 8xxx Utilities

***Note**: GSS8000-series signal generators use IP to communicate with the SimGEN Controller. Other signal generators use the IEEE-488 bus. All relevant utilities automatically determine the correct communication protocol to use.*

These utilities are the same as in ***4750 / 60 / 80 / 90 Utilities*** (page 26-7).

## 26.5 7xxx/9xxx Utilities

This table shows the SimGEN utilities available in the menu item **Tools-*7xxx/9xxx Utilities***.

| 7xxx/9xxx Utilities |
|---|
| ***IEEE-488 or IP String Send Utility*** (page 26-7) |
| ***Channel alignment*** (page 26-21) |
| ***NVRAM backup*** (page 26-21) |
| ***FPGA Image Loader*** (page 26-22) |
| ***Host Controller*** (page 26-25) |
| ***BIOS Battery Status*** (page 26-29) |

### 26.5.1 Channel alignment

***Note**: Currently, you must manually calibrate your GSS9000-series signal generator, contact Spirent for details*

### 26.5.2 NVRAM backup

***Note**: Currently, you must manually backup the NVRAM in your GSS9000-series signal generator, contact Spirent for details*


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### 26.5.3 FPGA Image Loader

***Notes**:*

***1)** You can only open one instance of the **FPGA Image Loader***

***2)** If the **FPGA Image Loader** dialog does not display the IP addresses or serial numbers of all signal generators connected to your C50r SimGEN Host (or your GSS7000 signal generator), Spirent recommends you reboot your C50r SimGEN Host (or GSS7000 signal generator) then navigate to, and open the Image loader executable FPGA_Image_Loader.exe.*
*If this problem persists, contact Spirent Global Services.*

Use the **FPGA Image Loader** to update these FPGAs:

| Module | **GSS9000-series signal generator** | **GSS7000** signal generator |
|---|---|---|
| Signal Generator | ✓ | ✓ |
| RF Upconverter | ✓ | ✓ |
| Timer | ✓ | ✓ |
| Calibrator | ✓ | not applicable |
| FPGA (authorised users only) | ✓ | not applicable |

Follow the appropriate procedure to use the **FPGA Image Loader** (you must follow each step, as described).

**For a GSS9000-series signal generator:**

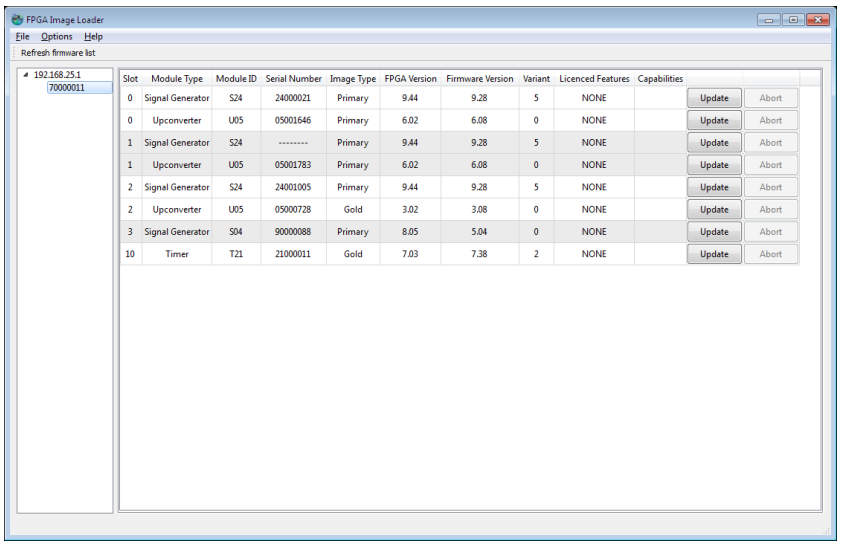
- Ensure your C50r SimGEN Host has the latest version of PosApp installed
- Connect your C50r SimGEN Host to your GSS9000-series signal generator using the PCIe cable
- Turn on AC power to your GSS9000-series signal generator
- Wait for at least one minute
- Turn on AC power to your C50r SimGEN Host
- Wait for Windows to load
- Navigate to the Spirent software folder on your C50r SimGEN Host, default location *D:\posapp\software\<version>\gui*
- Double-click *FPGA_Image_Loader.exe*.

**For a GSS7000 signal generator:**

- Ensure your Embedded Host has the latest version of PosApp installed
- Turn on AC power to your GSS7000 signal generator
- Start your GSS7000 signal generator by pressing the front panel on / off switch
- Wait for Windows to load
- Navigate to the Spirent software folder on your GSS7000 Embedded Host, default location *D:\posapp\software\<version>\gui*
- Double-click *FPGA_Image_Loader.exe*.

The **FPGA Image Loader** dialog opens and automatically selects the first signal generator in the list in the left-hand area. This figure shows a GSS7000 signal generator:


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| | |
|---|---|
| **Slot** | The signal generator card frame slot where the module is installed |
| **Module Type** | Lists each module type in the currently selected signal generator |
| **Module ID** | Lists the Spirent Module ID |
| **Serial Number** | Lists each Module serial number |
| **Image Type** | Type of image currently running, either **Gold** or **Primary** |
| **FPGA Version** | Version of FPGA currently installed in each module |
| ***Note**: **FPGA Version** displays the currently running version* | |
| **Firmware Version** | Version of firmware currently running in each module |
| ***Note**: **Firmware Version** displays the currently running version* | |
| **Variant** | Displays FPGA variants |
| **Licenced Features** | Licenced features in any of the installed modules |
| **Capabilities** | A combination of the loaded image and whether a feature in the loaded image is licenced |
| **Update** | Click **Update**, then navigate to the image you want to install.<br>Images use the extension **.mcs*, for example:<br>*BBFR_S04_OR_SP0_02-33_02-14_KZZZ_I1.mcs* |
| **Abort** | **Abort** appears after selecting an image.<br>Click to cancel updating the FPGA image for that module.<br>Loading first deletes the original FPGA image then loads the new FPGA image. |
| ***Note**: Clicking **Abort** does not restore the original FPGA image for that module, it will remain deleted. You must then reload this image to restore your module to its previous state* | |

Spirent recommends you take a screenshot of this dialog, or record the information for each module whose FPGA you want to update. Use the procedure at the end of this section to determine if the update was successful.

To apply a new FPGA image to a module:

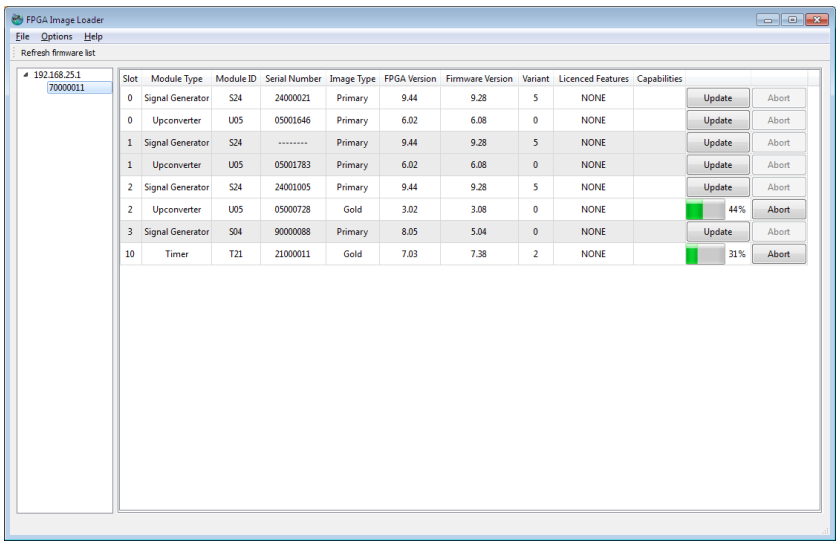
→ Click **Update** corresponding to the module you want to update

→ Navigate to the FPGA image for that module

→ Click **OK**

→ The **Update** button changes to a progress bar and the loader begins loading the new image. For example, updating a GSS7000 signal generator:


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→ Once complete, the progress bar returns to an **Update** button

→ The **FPGA Image Loader** displays a message if the FPGA image you selected is incompatible with that module and will request you select a new image.

→ Click **Abort** to abort the update process

Repeat this process to update the FPGA in each module, as required.

After updating the last module, Spirent recommends you confirm the update(s) were successful, as follows:

**For a GSS9000-series signal generator:**

→ Turn off AC power to your GSS9000-series signal generator at the rear panel on/off switch

→ Turn off AC power to your C50r SimGEN Host

→ Turn on AC power to your GSS9000-series signal generator at the rear panel on/off switch

→ Wait for at least one minute

→ Turn on AC power to your C50r SimGEN Host

→ Re-run the **FPGA Image Loader**

→ Select the GSS9000-series signal generator whose FPGAs you have updated.

→ Compare the details in this dialog with the details you recorded earlier and ensure each module displays the updated details

**For a GSS7000 signal generator:**

→ Shutdown Windows on your GSS7000 signal generator

→ Turn off AC power to your GSS7000 signal generator at the rear panel AC switch

→ Wait for 30 seconds

→ Turn on AC power to your GSS7000 signal generator at the rear panel AC switch

→ Press the front panel on / off switch

→ Wait for Windows to load

→ Re-run the **FPGA Image Loader**

→ Compare the details in this dialog with the details you recorded earlier and ensure each module displays the updated details


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## 26.5.4 Host Controller

***Notes**:*

***1)** Each time you start SimGEN, it automatically synchronises the time of the Linux operating system with that of the Windows 7 Professional for Embedded Systems ESD (Virtualisation Only) operating system.*

***2)** The Linux operating system operates in UTC time only; whereas the Windows 7 Professional for Embedded Systems ESD (Virtualisation Only) operating system lets you change time zones and adjust for daylight saving.*

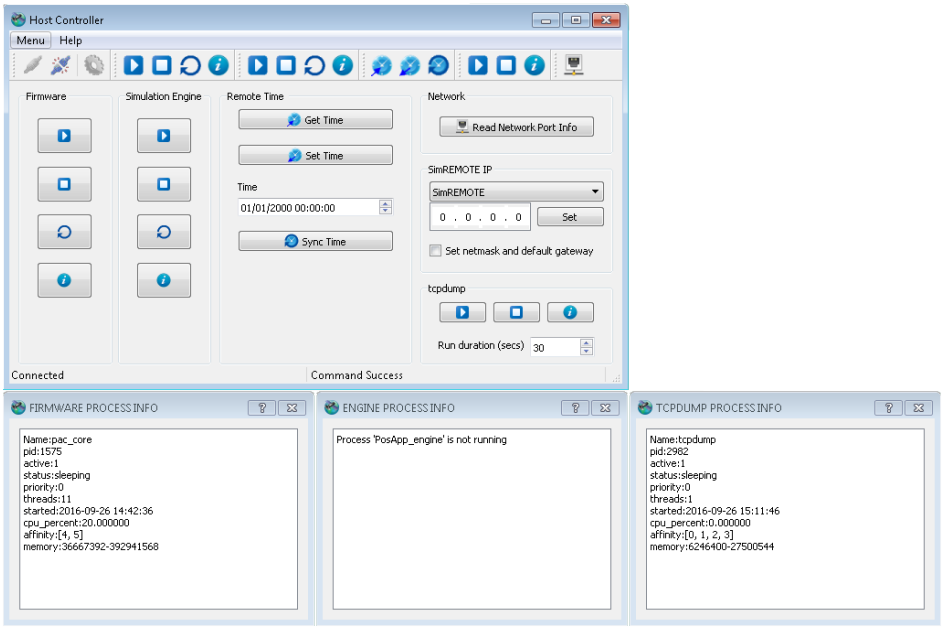
***3)** Spirent recommends you only use this utility under the guidance of a Spirent Global Support engineer.*

***4)** You must use unique IP addresses. Duplicate IP addresses may cause issues with connections to the D: drive or the Windows 7 Professional for Embedded Systems ESD (Virtualisation Only) operating system.*
*You can check the IP addresses currently in use by clicking **Read Network Port Info***

This utility lets you perform the following operations on the C50r SimGEN Host (or the GSS7000 Embedded Host), when running SimGEN:

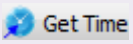
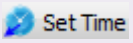
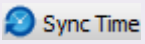
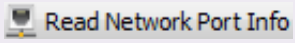
- Separately start, stop and reload the firmware and engine
- Manually synchronise the time between the Linux and Windows 7 Professional for Embedded Systems ESD (Virtualisation Only) operating systems
- Log network traffic

This utility installs to folder *D:\posapp\software\<version>\gui\Host_control.*

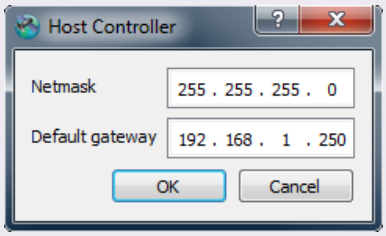



| | | | |
|---|---|---|---|
| **Firmware**, **Simulation Engine** provides separate control of the **Firmware** or **Simulation Engine** | | | |
|  | Click to start | **Firmware** shortcut: *Shift+F5* | **Simulation Engine** shortcut: *Ctrl+F5* |
|  | Click to stop | **Firmware** shortcut: *Shift+F6* | **Simulation Engine** shortcut: *Ctrl+F6* |
|  | Click to restart | **Firmware** shortcut: *Shift+F7* | **Simulation Engine** shortcut: *Ctrl+F7* |
|  | Click to show **PROCESS INFO** window, as shown in the figure above | **Firmware** shortcut: *Shift+F8* | **Simulation Engine** shortcut: *Ctrl+F8* |
| ***Note**: Using any shortcut will update both **PROCESS INFO** windows* | | | |
| **Remote time** display and change the Linux operating system time | | | |

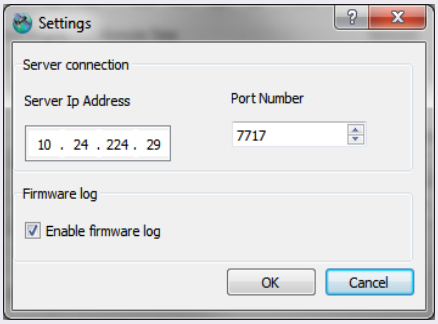

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| | |
|---|---|
|  | Click to get the Linux operating system time and display it in the **Time (in UTC)** area |
|  | Click to set the Linux operating system time to the time shown in the **Time (in UTC)** area |
| **Time** (in UTC) | Displays the Linux operating system time using the format:<br>**dd/mm/yyyy hh:mm:ss**<br>Select the parameter you want to change and type the new value, or select the new value with the up / down arrows |
|  | Click to set the Linux operating system to that of the Windows 7 Professional for Embedded Systems ESD (Virtualisation Only) operating system |
|  | Click to display the **Network Port Information** window, see below. |
| **SimREMOTE IP** | Sets the IP Address of the C50r SimGEN Host (or GSS7000 Embedded Host) rear panel port 'REMOTE'.<br>**To use DHCP for this port**<br>→ Type *0.0.0.0*<br>→ Click **Set**<br><br>**To use a static IP Address for this port**<br>→ Type the IP Address you want to use<br>→ Select **Set netmask and default gateway**<br>→ Enter the details for **Netmask** and **Default gateway**, in the **Host Controller** dialog, as detailed in **Set netmask and default gateway** below. Ensure you click **OK** in this dialog.<br>→ Click **Set**.<br><br>To correctly configure the IP Address of this port, you must shut down and restart the C50r SimGEN Host (or GSS7000 Embedded Host) using **Windows-Shut down**. Do not use **Windows-Restart** as this will not correctly configure the C50r SimGEN Host (or GSS7000 Embedded Host).<br><br>After your C50r SimGEN Host (or GSS7000 Embedded Host) has rebooted, start SimGEN and open this utility; then click **Read Network Port Info** to check your IP Address has been correctly set.<br>Reference vvv) also describes using this utility. |
| ***Notes***:<br>***1)*** *Clicking* **Set** *applies all details currently present in the* ***IP Address***, ***Netmask*** *and* ***Default Gateway*** *areas*<br>***2)*** *Only use the default selection* ***SimREMOTE*** *in the drop-down* | |


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| | |
|---|---|
| **Set netmask and default gateway** | Deselect: Automatically set **Netmask** and **Default gateway**.<br>Select: Enter appropriate **Netmask** and **Default gateway** addresses to use a static IP address. For example:<br>  <br><br>Alternatively, leave each entry blank to assign each address automatically.<br><br>Click **OK**<br>Clicking **Cancel** replaces all entries in the **Netmask** and **Default gateway** areas with blank fields and deselects **Set netmask and default gateway** in the A**imREMOTE IP** area.<br>after you click **OK** or **Cancel** in the **Host Controller** dialog you must click **Set** in the **SimREMOTE IP** area to apply the settings<br><br>The following example shows setting static SimREMOTE ports when using three C50r SimGEN Hosts on the same network:<br><br>**Router** (Internet connection):<br>IP address: 192.168.1.250<br>netmask: 255.255.255.0<br><br>**First C50r SimGEN Host**<br>Linux using SimREMOTE port (set using the Host Controller utility):<br>IP address: 192.168.1.1<br>netmask: 255.255.255.0<br>gateway: 192.168.1.250 (router)<br>Windows 7 using Local Area Connection (LAN-SimREMOTE):<br>IP address: 192.168.1.2<br>netmask: 255.255.255.0<br>gateway: 192.168.1.250 (router)<br><br>**Second C50r SimGEN Host**<br>Linux using SimREMOTE port (set using the Host Controller utility):<br>IP address: 192.168.1.3<br>netmask: 255.255.255.0<br>gateway: 192.168.1.250 (router)<br>Windows 7 using Local Area Connection (LAN-SimREMOTE):<br>IP address: 192.168.1.4<br>netmask: 255.255.255.0<br>gateway: 192.168.1.250 (router)<br><br>**Third C50r SimGEN Host**<br>Linux using SimREMOTE port (set using the Host Controller utility):<br>IP address: 192.168.1.5<br>netmask: 255.255.255.0<br>gateway: 192.168.1.250 (router)<br>Windows 7 using Local Area Connection (LAN-SimREMOTE):<br>IP address: 192.168.1.6<br>netmask: 255.255.255.0<br>gateway: 192.168.1.250 (router) |
| ***Note**: Manual settings of **Netmask** and **Default gateway** are not applied for DHCP* | |

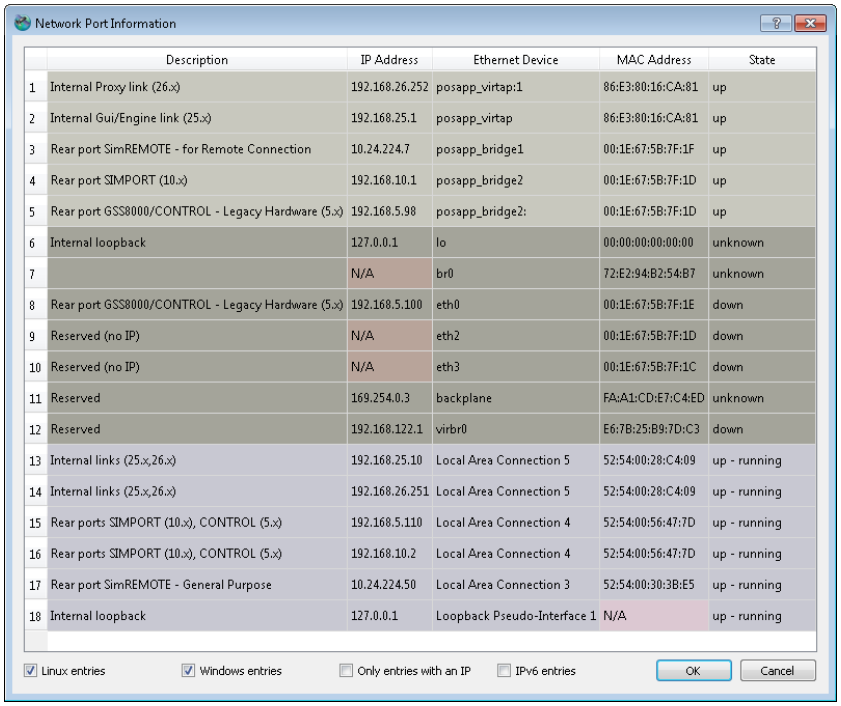

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| | |
|---|---|
| | **Remote PC1** sends remote commands using the Socket String Send utility to the engine in the first C50r SimGEN Host, IP address: 192.168.1.1, port 15650<br>Windows 7 - Local Area Connection:<br>IP address: 192.168.1.101<br>netmask: 255.255.255.0<br>gateway: 192.168.1.250 (router)<br><br>**Remote PC2** sends remote commands using the Socket String Send utility to the engine in the second C50r SimGEN Host, IP address: 192.168.1.3, port 15650<br>Windows 7 - Local Area Connection:<br>IP address: 192.168.1.102<br>netmask: 255.255.255.0<br>gateway: 192.168.1.250 (router)<br><br>**Remote PC3** sends remote commands using the Socket String Send utility to the engine in the third C50r SimGEN Host, IP address 192.168.1.5, port 15650:<br>Windows 7 - Local Area Connection:<br>IP address: 192.168.1.103<br>netmask: 255.255.255.0<br>gateway: 192.168.1.250 (router) |
| **tcpdump** logs all SimGEN network traffic to the file *filename.tcpd* in the Windows log folder, location: *D:/posapp/logs/posapp*.<br>Spirent recommends using Wireshark (www.wireshark.org) to view this file. | |
|  | Click to start the tcpdump process |
|  | Click to stop |
|  | Click to show the **TCPDUMP PROCESS INFO** window, as shown in the figure above |
| **Run duration (secs)** | Select, or type, the time over which you want to log SimGEN network traffic |
| | Units: seconds / Range: 1 to 600 s / Default: 30 |
| ***Note**: Only use **tcpdump** under the guidance of a* Spirent Global Services *engineer* | |
| **Status Bar** displays whether the utility is **Connected** or **Disconnected** to a GSS9000-series, or GSS7000, signal generator | |
| **Toolbar** (duplicates the **Firmware**, **Simulation engine**, **Remote Time**, **tcpdump** and **Network** buttons), in addition to: | |
|  | Connect to the C50r SimGEN Host (or GSS7000 Embedded Host) |
|  | Disconnect from the C50r SimGEN Host (or GSS7000 Embedded Host) |
|  | Click (or use **Menu-Settings**) to open the **Settings** dialog:<br>  <br>The firmware log file is stored in the Windows log folder: *D:/posapp/logs/posapp/fw_log.txt* |


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You can also access all these functions from **Menu**.

Clicking **Read Network Port Info** displays the **Network Port Information** window:




| | |
|---|---|
| **Linux entries** | Deselect: Do not show Linux entries<br>Select: Show Linux entries (shown in grey) |
| **Windows entries** | Deselect: Do not show Windows entries<br>Select: Show Windows entries (shown in blue) |
| **Only entries with an IP** | Deselect: Show all entries. Entries without an IP address are identified with N/A (and colour-coded as shown in the figure above)<br>Select: Show only entries with an IP address |
| **IPv6 entries** | Deselect: Show only IPv4 entries<br>Select: Show IPv4 and IPv6 entries (IPv6 entries are colour-coded) |

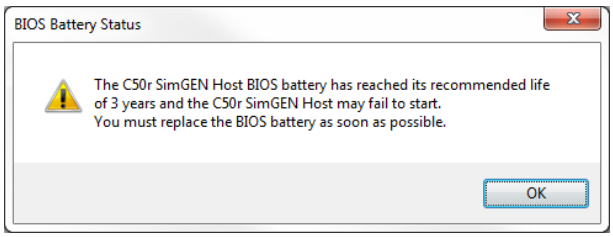
## 26.5.5 BIOS Battery Status

***Note for all users of the GSS9000-series signal generator and the C50r SimGEN Host**:*
*This utility displays information on the life of the BIOS battery installed in your C50r SimGEN Host. If the BIOS battery fails, your C50r SimGEN Host will be unable to operate the Virtual Machine, see **SimGEN running on the C50r SimGEN Host** (page 1-9), which will render your C50r SimGEN Host and your GSS9000-series signal generator unusable.*

***Note for all users of the GSS7000 signal generator and its Embedded Host**:*
*Currrently, SimGEN uses this **BIOS battery status** indication on the GSS7000 Embedded Host. However, in the event the BIOS battery fails, the Embedded Host BIOS will continue to operate the Virtual Machine and you will continue to be ablel to operate your GSS7000 as normal.*
*Currently, Spirent recommends you ignore any warnings to replace the BIOS battery and contact **Spirent Global Services** (page 28-1) to arrange for BIOS battery replacement, since the BIOS battery is not accessible to the user.*

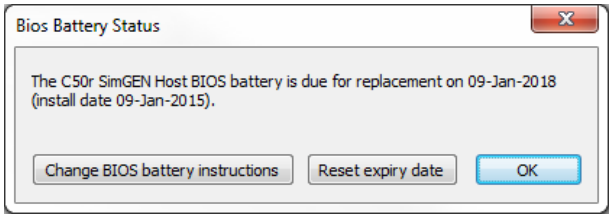
Spirent estimates the life of the C50r SimGEN Host BIOS battery to be no more than three years, and recommend you replace the BIOS battery at intervals not exceeding three years. On the third anniversary of the installation date of the BIOS battery, SimGEN automatically displays this dialog (the **System Messages** window also displays the same text):


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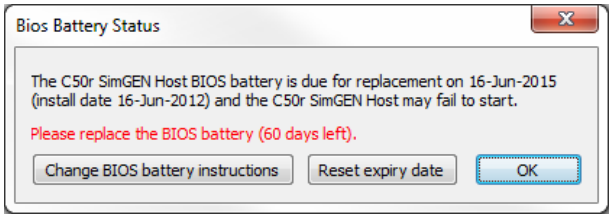



Use the **BIOS battery utility** to determine the time remaining before you must replace the BIOS battery. After running the utility:

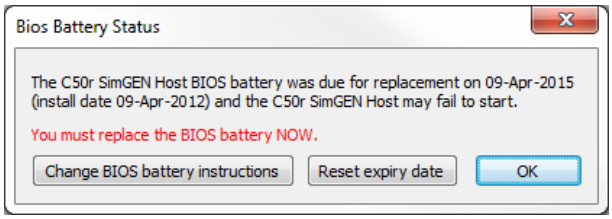
→ If there are more than 60 days to the third anniversary of the installation date of the BIOS battery, SimGEN displays a dialog detailing the replacement date (the **System Messages** window also displays the same text):




→ If there are 60 days, or fewer, to the third anniversary of the installation date of the BIOS battery, SimGEN displays a dialog detailing the number of days to this anniversary (the **System Messages** window also displays the same text):

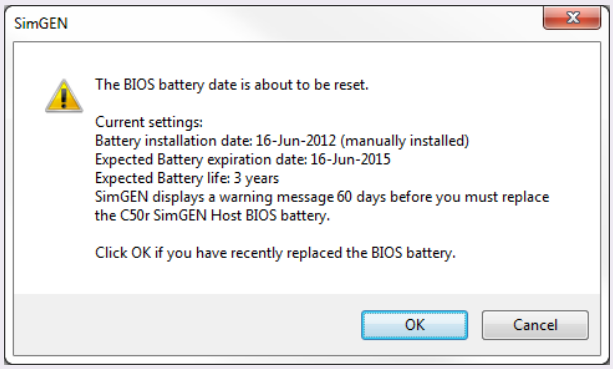



→ If the third anniversary of the installation date of the BIOS battery has expired, SimGEN displays a dialog stating you must replace the BIOS battery now (the **System Messages** window also displays the same text):




| | |
|---|---|
| **Change BIOS battery instructions** | Click to open the SimGEN help file at ***Replacing the C50r SimGEN Host BIOS battery*** (page 26-29), which details replacing the C50r SimGEN Host BIOS battery. |
| ***Note***: *Currently, you must contact* ***Spirent Global Services*** *for details on replacing the BIOS battery* | |


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| | |
|---|---|
| **Reset expiry date** | After changing the BIOS battery, click to open this dialog:<br>  <br><br>Click **OK** to reset the BIOS battery installation date to the current date. The dialog also shows the expected battery expiration date - Spirent recommends you replace the battery before this date. |
| **OK** | Click to close the utility |

## 26.6 General Utilities

***Notes**:*

***1)** GSS9000-series signal generators use PCIexpress to communicate with the C50r SimGEN Host.*

***2)** GSS8000-series signal generators use IP to communicate with the SimGEN Controller.*

***3)** Earlier signal generators use the IEEE-488 bus.*

*All utilities automatically determine the correct communication protocol to use.*

Use **Tools-General utilities** to access the utilities shown in this table:

| General utilities |
|---|
| ***Data Streaming Message Logger*** |
| ***Galileo Nav Data Extract*** (page 26-33) |
| ***GLONASS Nav Data Extract*** (page 26-34) |
| ***GPS L1C/A Nav Data Extract*** (page 26-36) |
| ***GPS/QZ L1C Nav Data Extract Utility*** (page 26-43) |
| ***NMEA Logging*** (page 26-46) |
| NMEA to User Command - see reference zz) |
| ***NMEA to User Motion*** (page 26-49) and see reference zz) |
| Plan Error Tool - see reference zz) |
| ***RTCM Decoder*** (page 26-51) |
| ***SBAS Nav Data Extract utility*** (page 26-51) |
| ***IRNSS Nav Data Extract utility*** (page 26-57) |
| ***BeiDou Nav Data Extract utility*** (page 26-58) |
| SimPROCESS - see reference zz) |
| ***Socket String Send*** (page 26-53) |
| ***Quasi-Zenith utilities*** (page 26-54) |
| ***IRNSS Nav Data Extract utility*** (page 26-57) |


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**General utilities**

*BeiDou Nav Data Extract utility* (page 26-58)

## 26.6.1 Data Streaming Message Logger

***Notes**:*

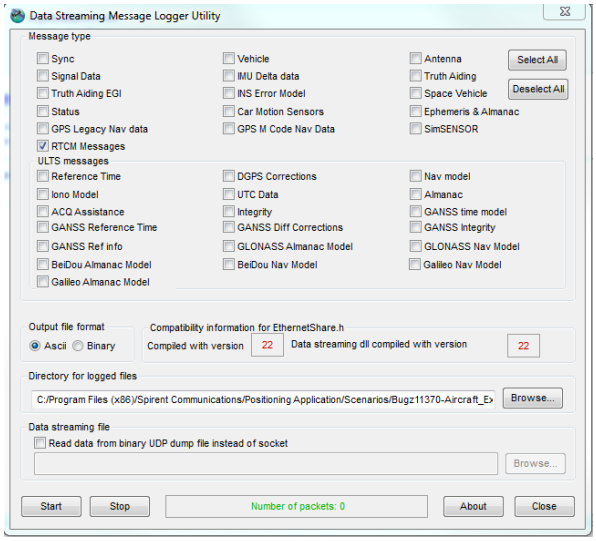
***1)** The Message Logger will only log the **Message types** you are authorised to use.*

***2)** Ensure the versions of Ethernetshare.h in the logger dialog are the same and match the version shown in **Data streaming definition file-General** (page 8-6). If the difference between any of the versions is greater than two, you cannot use the new features in the latest version. Contact Spirent for details on upgrading the data streaming dll file.*

***3)** C50r SimGEN Host users see **Important details for all users of the C50r SimGEN Host** (page 1-8)*

This utility (“Message Logger”) lets you log data streaming messages SimGEN produces while running a scenario. You can log messages as SimGEN produces them, or log the messages from a data streaming file.

You must first set-up the scenario for data streaming, see **<scenario name>-Options-***Data streaming definition file* (page 8-6).




| | |
|---|---|
| **Message type** | Select the message type to log.<br>See Note 1) above. |
| **Select All** | Click to select all message types to log.<br>See Note 1) above. |
| **Deselect All** | Click to deselect all message types. |
| **Output file format** | Choose from:<br>**Ascii** (default),or<br>**Binary** |
| **Compatibility information for Ethernetshare.h** | Displays the version number, see Note 2) above. |
| **Directory for logged files** | Click **Browse** and navigate to the folder you want to use. The logger produces one file for each **Message type** you selected. |
| **Data streaming file** | |
| **Read data from binary UDP dump file instead of socket** | Deselect (default): reads data from socket<br>Select: reads data from dump file and enables text box, click **Browse** and navigate to the dump file (**.bin*) you want to use. ***IP address*** (page 22-6) details copying data messages to a Binary file. |


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| | |
|---|---|
| **Start** | Click to start logging data streaming messages. You can click **Start** at any time before or after starting the scenario. To get a full run of data you must click **Start** before starting the scenario.<br>Except for the buttons, the message logger disables the user interface after you click **Start**.<br>When running, a counter, positioned between the buttons, see the figure above, shows the number of packets read. |
| **Stop** | Click to stop logging data streaming messages. You can stop logging messages while a scenario is running and restart logging later in the scenario.<br>Before you open any log file, stop the Message Logger by clicking **Stop**. |

## 26.6.2 Galileo Nav Data Extract

***Notes**:*

***1)** This utility automatically determines the message type from C/NAV, F/NAV or I/NAV.*

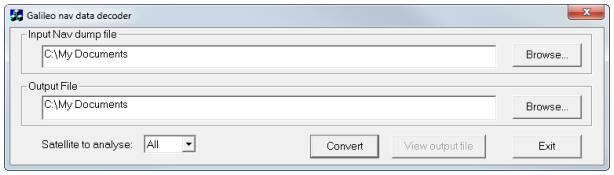
***2)** Before running the scenario, select the menu item **Options-**General Options **-Dump navigation data** (page 5-15) to write navigation data files to the scenario folder*

Use this utility to extract Galileo navigation data and save it to a text file.

SimGEN will write Galileo navigation data messages to one of the following binary files, located in the current scenario folder:

*Gal_cnav_data.bin*
*Gal_fnav_data.bin*
*Gal_inav_data_E5b.bin*
*Gal_inav_data_L1_B.bin*

After the scenario finishes, start the **Galileo Nav Data Extract** utility, by selecting **Tools-General Utilities-Galileo Nav Data extract**.




| | |
|---|---|
| **Input Nav dump file** | Click **Browse** and navigate to the file you want to use |
| **Output File** | Click **Browse** and navigate to the folder where you want to store the extracted data with a filename of your choice |
| **Satellite to analyse** | Choose to decode data from:<br>**All** (default),or<br>select the SVID of a specific satellite |
| **Convert** | Click to begin the conversion |
| **View output file** | Click to view the decoded output file |

The next section details using parameters to run this utility from the command line.

### 26.6.2.1 Command line parameters

***Note**: This section uses the same syntax as the remote commands in reference qq)*

You can run the **Galileo Nav Data Extract** utility from the command line using these parameters:

| | | | |
|---|---|---|---|
| **Command** | galileo_nav_decode.exe “-infile” <infile> “-outfile” <outfile> “-svid” <svid> “-autorun” <autorun> | | |
| **Where** | infile | ::= | The location of the input binary file for decoding.<br>You must specify the full path and file name in inverted commas. |

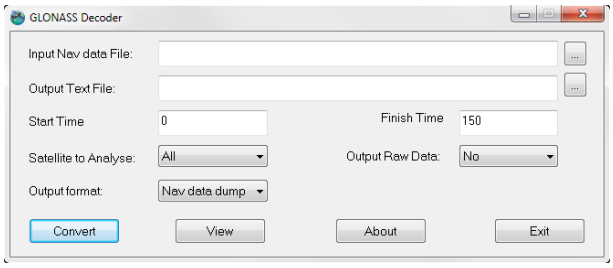

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| | | | |
|---|---|---|---|
| | outfile | ::= | The location of the decoded output file.<br>You must specify the full path and file name in inverted commas |
| | svid | ::= | 0-36<br>The svid of the satellite for which you want to decode nav data.<br>Use “0” to decode data from all satellites. |
| | autorun | ::= | “0” (| “no”) | “1” (|“yes”)<br>“0”<br>Loads the utility with the infile and outfile you specify in the command line.<br>Does not automatically run the utility.<br>“1”<br>Loads the utility with the infile and outfile you specify in the command line.<br>Automatically runs the utility.<br>The utility exits after decoding the infile. |
| **Example** | Automatically run the utility from the command line using this input file *C:\Program Files\Spirent Communications\Positioning Application\Scenarios\scenario1 \Scenarios\FNAV_data.bin*, and save the output file as *…Positioning Application\Scenarios \scenario1\FNAV_decoded.txt*, decode data for all satellites, exit the utility when finished.<br><br>galileo_nav_decode.exe<br>-infile "C:\Program Files\Spirent Communications\Positioning Application\Scenarios\ scenario1\FNAV_data.bin"<br>-outfile "C:\Program Files\Spirent Communications\Positioning Application\Scenarios\ scenario1<br>\FNAV_decoded.txt" -svid 0 -autorun "yes" | | |

### 26.6.3 GLONASS Nav Data Extract

***Note**: Before running the scenario, select the menu item **Options-**General Options **-Dump navigation data** (page 5-15) to write navigation data files to the scenario folder*

This utility extracts GLONASS navigation data to a text file. The GLONASS navigation data file has a **.gnv* extension.




After the scenario has finished, start the decoder by selecting **Tools-General Utilities-Galileo Nav Data extract**,

| | | | |
|---|---|---|---|
| **Input Nav data file** | Click **…** and navigate to the file you want to use | | |
| **Output Text File** | Click **…** and navigate to the folder where you want to store the extracted data with a filename of your choice | | |
| **Start Time** | Type the time into run at which you want to start decoding the data | | |
| | Units: integer seconds | Range: greater than 0 s | Default: 0 |
| **Finish Time** | Type the time into run at which you want to finish decoding the data. | | |
| | Units: integer seconds | Range: greater than 0 s | Default: 150 |
| **Satellite to Analyse** | Choose to decode data from:<br>**All** (default),or<br>select the SVID of a specific satellite | | |


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| | |
|---|---|
| **Output Raw Data** | Choose from:<br>**No** (default),or<br>**Yes** - to output raw data to the decoded data file |
| **Output format** | Chose from:<br>**Nav data dump** (default) - decodes and dumps Navigation data from the **Input Nav data file** you select<br>**UDD** - generates a **.eph_glo* file from the **Input Nav data file** you select. You can use this file to modify satellite orbits. |
| **Convert** | Click to begin the conversion |
| **View output file** | Click to view the decoded output file |

#### 26.6.3.1 Command line parameters

***Note**: This section uses the same syntax as the remote commands in reference qq)*

You can run the **GLONASS Nav Data Extract** utility from the command line using these parameters:

| | | | |
|---|---|---|---|
| **Command** | GlonassDecoder.exe “-infile” <infile> “-outfile” <outfile><br>“-svid” <svid> “-start” <start> “-finish” <finish><br>“-raw” <raw> “-format” <format> “-autorun” <autorun> | | |
| **Where** | infile | ::= | The location of the input GLONASS binary file for decoding.<br>You must specify the full path and file name in inverted commas. |
| | outfile | ::= | The location of the decoded output file.<br>You must specify the full path and file name in inverted commas |
| | svid | ::= | 0-24<br>The svid of the satellite for which you want to decode nav data. Use “0” to decode data from all satellites. |
| | start | ::= | The time in integer seconds at which you want to start decoding nav data. Greater than or equal to 0 |
| | finish | ::= | The time in integer seconds at which you want to finish decoding nav data |
| | raw | ::= | “0” (Does not display raw data in the decoded file)<br>\|<br>“1” (Displays raw data in the decoded file) |
| | format | ::= | “0” (Generates a navigation data dump)<br>\|<br>“1” (Generates a **.eph_glo* file for UDD) |
| | autorun | ::= | “0” (\| “no”)<br>Loads the utility with the infile and outfile you specify in the command line.<br>Does not automatically run the utility<br>\|<br>“1” (\| “yes”)<br>Loads the utility with the infile and outfile you specify in the command line.<br>Automatically runs the utility.<br>The utility exits after decoding the infile. |
| **Example** | Automatically run the utility from the command line using this input file *C:\Program Files\Spirent Communications\Positioning Application \Scenarios\scenario1\nav_data.gnv.*<br>Save the output file as *…Positioning Application\Scenarios \scenario1\glonass_decoded.txt.*<br>Decode data for all satellites, starting at 0 s, finishing at 120 s.<br>Do not display raw data in the outfile. Generate a navigation data dump file. Exit the utility when finished.<br><br>GlonassDecoder.exe<br>-infile "C:\Program Files\Spirent Communications\Positioning Application\Scenarios\ scenario1\nav_data.gnv"<br>-outfile "C:\Program Files\SpirentCommunications\Positioning Application\Scenarios\ | | |


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scenario1\glonass_decoded.txt"
-svid 0 -start 0 -finish 120 -raw 0 -format 0 -autorun "yes"

### 26.6.4 GPS L1C/A Nav Data Extract

***Notes**:*

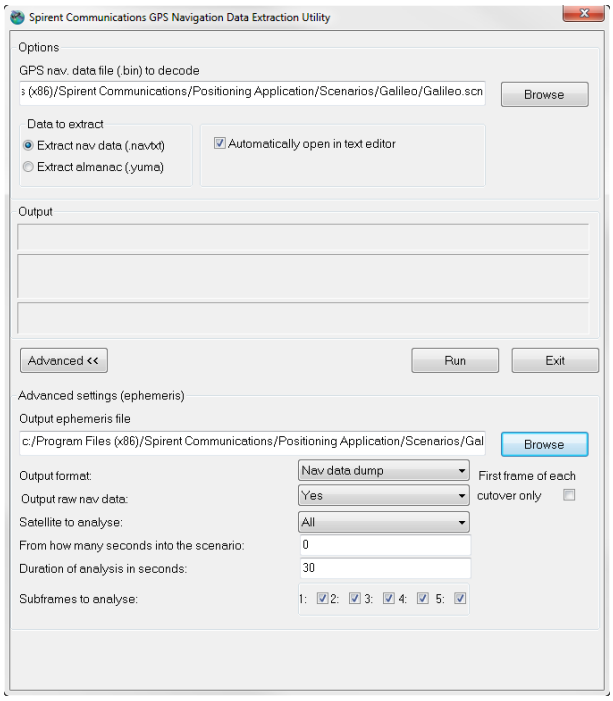
***1)** The **Advanced** dialog opens by default*

***2) Quasi-Zenith-L1C/A Navigation Data Extract utility** (page 26-54) uses a variant of this utility.*

***3)** Before running the scenario, select the menu item **Options-General Options-Dump navigation data** (page 5-15) to write navigation data files to the scenario folder*

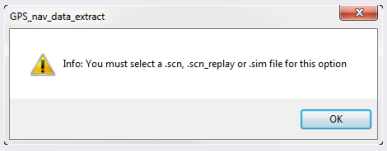
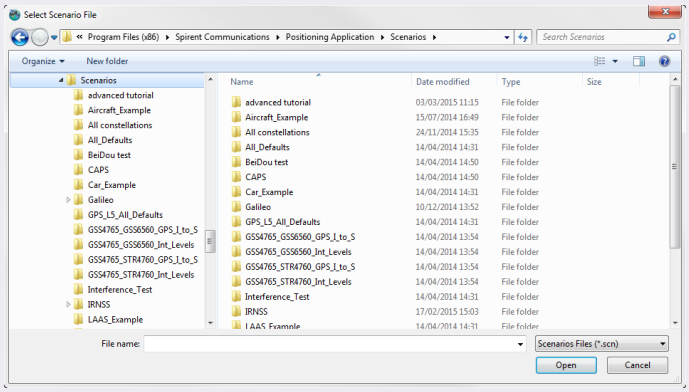
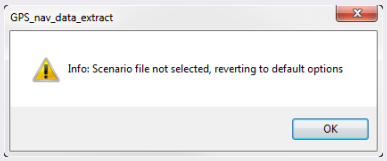
The GPS Navigation Data Extraction utility decodes the binary navigation data file into ASCII text so you can view navigation data. You can use this data, for example, to generate Assistance messages (as in A-GPS).

SimGEN writes navigation data messages to the binary file, *gps_nav_dump.bin*, located in current scenario folder.

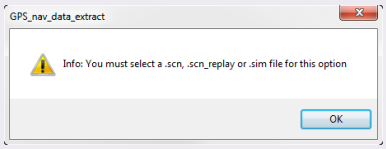
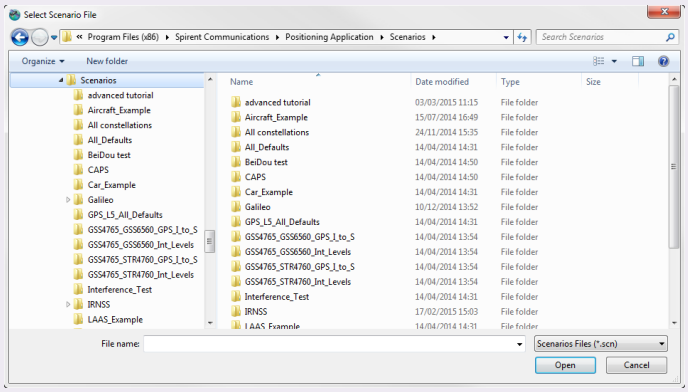
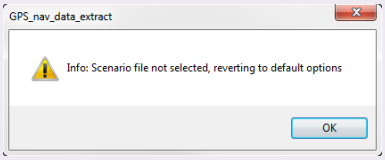



| | |
|---|---|
| **Options** | Click **Browse** and navigate to the nav data file (**.bin*) you want to use.<br>Notice a Spirent **.scn* file defines a SimGEN scenario, which by default are located in the folder: *C:\Program Files\SpirentCommunications\Positioning Application\Scenarios* |


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| | |
|---|---|
| **Data to extract** | Choose from:<br>**Extract nav data (.navtxt)** (default),or<br>**Extract almanac (.yuma)**, this selection then displays:<br>A reminder to select the appropriate file:<br>  <br><br>Clicking **OK** opens the **Select Scenario File** dialog:<br>  <br><br>A reminder if you click **Cancel** in the **Select Scenario File** dialog:<br>  <br><br>Clicking **OK** in this window reverts your selection of **Extract almanac (.yuma)** back to the default **Extract nav data (.navtxt)** |
| **Automatically open in text editor** | Choose from:<br>Selected (default): opens the file in WordPad<br>Deselect if you do not need to see the file in WordPad |
| **Output area** | Shows the path and filename of the data file in use and the output file, together with conversion progress |
| **Advanced** | Click to toggle the **Advanced settings (ephemeris)** area. The figure above shows the **Advanced** dialog, the figure below shows the **Advanced** dialog closed |
| **Run** | Click to begin the conversion |
| **Advanced settings (ephemeris) area** | |
| **Output ephemeris file** | Click **Browse** and type the name of the Output ephemeris file. By default, this file is written to the current scenario's folder. |


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<table>
<tr><td>Output format</td><td>Choose the format of the output file from:<br>Nav data dump (default)<br>UDD - use to import data into another scenario using GPS Constellation-Enable user defined data-Sat orb data file or -Eph nav data file. See Satellite orbital data file (page 20-5) and Ephemeris navigation data file (page 20-6) respectively.<br>This selection displays a reminder to select the appropriate file:<br>  <br>Clicking OK opens the Select Scenario File dialog:<br>  <br>A reminder if you click Cancel in the Select Scenario File dialog:<br>  <br>Clicking OK in this window reverts your selection to the default Nav data dump<br><br>Note: To import the extracted files as user-defined data files, you must rename the extracted data files from *.navtxt to *.eph.<br>GNSS – gives backwards compatibility with Galileo, but from SimGEN 2-84 onwards, Spirent recommends you use the Galileo Nav Data Extract utility (page 26-33).<br>Displays the same reminders as in UDD, above.</td></tr>
<tr><td>Output raw nav data</td><td>Choose from:<br>Yes (default) - provides the navigation data bit-stream in hexadecimal characters as well as the decoded data fields<br>No - does not output raw navigation data</td></tr>
<tr><td>Satellite to Analyse</td><td>Choose to decode data from:<br>All (default),or<br>select the SVID of a specific satellite</td></tr>
<tr><td rowspan="2">From how many seconds into the scenario</td><td colspan="3">Type the number of seconds into the scenario you want to start extracting navigation data</td></tr>
<tr><td>Units: integer seconds</td><td>Range: greater than 0 s</td><td>Default: 0</td></tr>
<tr><td rowspan="2">Duration of analysis in seconds</td><td colspan="3">Type the duration, beginning at the time you typed in From how many seconds into the scenario</td></tr>
<tr><td>Units: integer seconds</td><td>Range: greater than 0 s</td><td>Default: 15 300</td></tr>
</table>


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| | |
|---|---|
| **First frame of each cutover only** | Choose from:<br>Deselected (default) - outputs all frame data<br>Select - outputs changes in frame data |
| **Subframes to analyse** | Choose from:<br>**Selected: 1** to **5** (default),or<br>Select the combination of subframes you want to analyse |

#### 26.6.4.1 Command line parameters

***Note**: This section uses the same syntax as the remote commands in reference qq)*

You can run the **GPS L1C/A Nav Data Extract** utility from the command line using these parameters:

| | | | |
|---|---|---|---|
| **Command** | GPS_nav_data_extract.exe “-infile” <infile> “-outfile” <outfile> “-autoshow” <autoshow> “-autorun” <autorun> “-extractyuma” <extractyuma> “-format” <format> “-raw” <raw> “-cutovers“ <cutovers> “-svid” <svid> “-from” <from> “-duration” <duration> “-subframes” <subframes> “-qz” <qz> | | |
| **Where** | infile | ::= | The location of the input binary NAV file for decoding. You must specify the full path and file name in inverted commas. |
| | outfile | ::= | The location of the decoded output file. You must specify the full path and file name in inverted commas. (Default is the current scenario directory ) |
| | autoshow | ::= | Automatically open decoded output in Windows Notepad.<br><br>“yes” [| “y”][| “1”] (Default - opens the decoded output in Notepad)<br>\|<br>“no” [| “n”][| “0”] (Do not open the decoded output in Notepad) |
| | autorun | ::= | Automatically run utility with infile and outfile you specify<br><br>“no” [| “n”][| “0”] (Default - loads the utility. Does not automatically run the utility.)<br>\|<br>“yes” [| “y”][| “1”] (Loads and automatically runs the utility. The utility exits after decoding the infile.) |
| | extractyuma | ::= | Choose decoded data format<br><br>“no” [| “n”][| “0”] (Default - decodes data to nav file)<br>\|<br>“yes” [| “y”][| “1”] (Decodes data to Yuma files) |
| | format | ::= | Choose format of output file<br><br>“nav” (Default - outputs to nav data dump)<br>\|<br>“udd” (outputs to udd)<br>\|<br>“gnss” (outputs to gnss) |
| | raw | ::= | Choose whether raw data is output<br><br>“yes” [| “y”][| “1”] (Default - raw data is output)<br>\|<br>“no” [| “n”][| “0”] |


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| | | |
|---|---|---|
| cutovers | ::= | Choose cutover frames<br><br>“no” [| “n”][| “0”] (Default - all frames)<br>\|<br>“yes” [| “y”][| “1”] (only first frame) |
| svid | ::= | SVID of satellite for which you want to decode nav data<br>“ALL” | (0 - 95)<br>(Use “ALL” to decode data from all satellites) |
| from | ::= | Integer seconds into scenario from which to start decoding<br>(No parameter = 0, start of scenario) |
| duration | ::= | Duration of scenario to decode, integer seconds<br>(No parameter = 30 seconds) |
| subframes | ::= | Select subframes from NAV data<br>“1” | “2” | “3” | “4” | “5”<br>(No parameter = all subframes) |
| qz | ::= | Decode data from GPS or Quasi-Zenith satellites<br><br>“no” [| “n”][| “0”] (Default - decode data from GPS satellites only)<br>\|<br>“yes” [| “y”][| “1”] (Decode data from QZ satellites only) |

**Examples**

Automatically run the utility from the command line using this input file *C:\Program Files\Spirent Communications\Positioning Application\Scenarios\scenario1\foo.scn*, and save the output file as…*\Positioning Application\Scenarios\scenario1\foo_decoded,*
Automatically open output file in Windows Notepad. Automatically decode data and exit utility. Decode to Yuma format. Output format is nav data dump. Don’t use cutovers. Decode data from all satellites. Start decoding 10 seconds from scenario start. Duration of data to decode is 40 seconds. Decode all 5 subframes. Decode data only from GPS satellites

GPS_nav_data_extract.exe -infile "C:\Program Files\Spirent Communications\Positioning Application\Scenarios\scenario1\foo.scn" -outfile "C:\Program Files\Spirent Communications\Positioning Application\Scenarios\scenario1\foo_decoded" –autoshow yes -autorun yes -extractyuma yes -format nav -raw yes -cutovers no -svid ALL -from 10 -duration 40 -subframes -qz no

### 26.6.4.2 Example output - Yuma ALMANAC format

Data for one satellite only is shown here:

```
**** Week 123 almanac for PRN-1 ***********
ID:              1
Health:            0
Eccentricity:         0.0000000000e+000
Time of Applicability (s):  4.7923200000e+005
Orbital Inclination (rad):  5.5561065674e-003
Rate of Right Ascen (r/s):  0.0000000000e+000
SQRT(A) (m^1/2):       5.1537006836e+003
Right Ascen at TOA (rad):   7.6349103451e-001
Argument of Perigee (rad):  0.0000000000e+000
Mean Anom (rad):       8.8181352615e-001
Af0 (s):           0.0000000000e+000
Af1 (s/s):          0.0000000000e+000
week:             123
```

### 26.6.4.3 Example output - EVTP ephemeris format

Data for 1 satellite only is shown here:

```
Channel #1:
**** Week 123 at GPS time 693882498.00 ephemeris for SV-1 ***********
ID:                1
Health:              0
Issue of Data (Ephemeris):          0
Sine Harm Corr Term to Orb rad (Crs,meters):     0.0000000000e+000
```


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```
Mean Motion Difference (delta n,semi-circles/sec):  0.0000000000e+000
Mean Anomaly (semi-circles):          9.8966315761e-001
Cos Harm Corr Term to Arg Lat (Cuc,radians):     0.0000000000e+000
Eccentricity:               0.0000000000e+000
Sine Harm Corr Term to Arg Lat (Cus,radians): 0.0000000000e+000
Sqrt(A) (meters):           5.1537008114e+003
Time of ephemeris (toe,seconds):       1.8000000000e+005
Cos Harm Corr Term to Angle of Incl (Cic,radians):  0.0000000000e+000
Right Ascension (omega0,semi-circles):   7.6349106384e-001
Sine Harm Corr Term to Angle of incl (Cis,radians): 0.0000000000e+000
Inclination Angle at Reference Time (i0,semi-circle):3.0555555550e-001
Cos Harm Corr Term to Orbit Radius (Crc,meters): 0.0000000000e+000
Arg of Perigee (w,semi-circles):       0.0000000000e+000
Rate of Right Ascension (omegadot,semi-circles/sec):  0.0000000000e+000
Rate of Inclination Angle (IDOT,semi-circles/sec):  0.0000000000e+000
C/A or P on L2 Bits (discretes):       1
HOW bit 18:              0
HOW bit 19:              0
URA Index:               0
ISSUE OF DATA CLOCK:             0
L2 P data flag:             0
Estimated Group Delay Differential:      0.0000000000e+000
Clock Data Reference Time (sec):       1.8000000000e+005
Second order coefficient af2 (sec/sec**2):    0.0000000000e+000
First order coefficient af1 (sec/sec):   0.0000000000e+000
Zero order coefficient af0 (sec):      0.0000000000e+000
Ephemeris reference week number:       123
```

#### 26.6.4.4 Example output - Nav Data extract format (with raw data dump)

Data for a set of 5 subframes for one satellite only, is shown here:

```
Analysis of the RT DEBUG file

Produced on Tuesday, February 26, 2002

Analysis is for SVID: 2

1:08:30 SUBFRAME 1 WORD 1 = 22EAAA8A
1:08:30 SUBFRAME 1 WORD 2 = 0E65C164
1:08:30 SUBFRAME 1 WORD 3 = 07B40002
1:08:30 SUBFRAME 1 WORD 4 = 0AAAAABF
1:08:30 SUBFRAME 1 WORD 5 = 15555543
1:08:30 SUBFRAME 1 WORD 6 = 15555543
1:08:30 SUBFRAME 1 WORD 7 = 15557FCF
1:08:30 SUBFRAME 1 WORD 8 = 3FF50366
1:08:30 SUBFRAME 1 WORD 9 = 00000029
1:08:30 SUBFRAME 1 WORD 10 = 3FFFFF20

1:08:30 Preamble  1  8B      hex
1:08:30 Subframe  id 1  1    none
1:08:30 Telemetry 1  2AAA    ! hex
1:08:30 Trunc time of week 1 732E29486 none
1:08:30 Alert flag  1  0  0  ! none
1:08:30 Anti-Spoof flag  1  0  0  ! none
1:08:30 Week no   7B 123       week
1:08:30 Ca or p code   1  1    none
1:08:30 Satellite accuracy  0  0  see Stanag
1:08:30 Satellite health  0    hex
1:08:30 Issue of data clock 0  0  none
1:08:30 L2 p data flag 0  0  ! none
1:08:30 Tgd correction 0 0.0000000000E+000  seconds
1:08:30 Clock data ref time 2BF2 1.8000000000E+005  seconds
1:08:30 Af2  0 0.0000000000E+000  s/s**2
1:08:30 Af1  0 0.0000000000E+000  s/s
1:08:30 Af0  0 0.0000000000E+000  seconds

1:08:36 SUBFRAME 2 WORD 1 = 22EAAA8A
1:08:36 SUBFRAME 2 WORD 2 = 0E65E20C
1:08:36 SUBFRAME 2 WORD 3 = 00000000
1:08:36 SUBFRAME 2 WORD 4 = 000024FC
1:08:36 SUBFRAME 2 WORD 5 = 2E731162
1:08:36 SUBFRAME 2 WORD 6 = 00000029
```


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```
1:08:36 SUBFRAME 2 WORD 7 = 3FFFFFD6
1:08:36 SUBFRAME 2 WORD 8 = 00002845
1:08:36 SUBFRAME 2 WORD 9 = 3C992F14
1:08:36 SUBFRAME 2 WORD 10 = 0AFC8AC8
1:08:36 Preamble 2    8B      hex
1:08:36 Subframe id 2   2     2 ! none
1:08:36 Telemetry 2   2AAA      ! hex
1:08:36 Trunc time of week 2 732F    29487 none
1:08:36 Alert flag 2    0     0 ! none
1:08:36 Anti-Spoof flag 2  0     0 ! none
1:08:36 Issue of data eph 2  0     0 none
1:08:36 Crs sin harmonic corr 0 0.0000000000E+000 metres
1:08:36 Mean motion diff  0 0.0000000000E+000 semi-c/s
1:08:36 Mean anomaly  93B9CC45 -8.4589239722E-001 ! semi-c
1:08:36 Cuc cos harmonic corr 0 0.0000000000E+000 radians
1:08:36 Eccentricity   0 0.0000000000E+000 ! none
1:08:36 Cus sin harmonic corr 0 0.0000000000E+000 radians
1:08:36 Root semi major A10D9B43 5.1537008114E+003 ! metres**1/2
1:08:36 Ref time eph   2BF2 1.8000000000E+005 seconds
1:08:36 Fit interval flag  0     0 ! none
1:08:42 SUBFRAME 3 WORD 1 = 22EAAA8A
1:08:42 SUBFRAME 3 WORD 2 = 0E660360
1:08:42 SUBFRAME 3 WORD 3 = 00001878
1:08:42 SUBFRAME 3 WORD 4 = 2E84CFCF
1:08:42 SUBFRAME 3 WORD 5 = 3FFFF61B
1:08:42 SUBFRAME 3 WORD 6 = 38E38E36
1:08:42 SUBFRAME 3 WORD 7 = 00000029
1:08:42 SUBFRAME 3 WORD 8 = 3FFFFFD6
1:08:42 SUBFRAME 3 WORD 9 = 00000029
1:08:42 SUBFRAME 3 WORD 10 = 3FFFFF20

1:08:42 Preamble 3    8B      hex
1:08:42 Subframe id 3   3     3 none
1:08:42 Telemetry 3   2AAA      ! hex
1:08:42 Trunc time of week 3 7330    29488 none
1:08:42 Alert flag 3    0     0 ! none
1:08:42 Anti-Spoof flag 3  0     0 ! none
1:08:42 Cic cos harmonic   0 0.0000000000E+000 radians
1:08:42 Long of asc node 61BA133F 7.6349106384E-001 ! semi-c
1:08:42 Cis sine harmonic corr 0 0.0000000000E+000 radians
1:08:42 Inclination  271C71C7 3.0555555550E-001 ! semi-c
1:08:42 Crc cos harmonic corr 0 0.0000000000E+000 metres
1:08:42 Arg perigee    0 0.0000000000E+000 ! semi-c
1:08:42 Right asc rate   0 0.0000000000E+000 semi-c/s
1:08:42 Issue of data eph 3  0     0 none
1:08:42 Inclination rate   0 0.0000000000E+000 semi-c/s

1:08:18 SUBFRAME 4 WORD 1 = 22EAAA8A
1:08:18 SUBFRAME 4 WORD 2 = 0E6584E8
1:08:18 SUBFRAME 4 WORD 3 = 1F2AAA93
1:08:18 SUBFRAME 4 WORD 4 = 15555543
1:08:18 SUBFRAME 4 WORD 5 = 15555543
1:08:18 SUBFRAME 4 WORD 6 = 15555543
1:08:18 SUBFRAME 4 WORD 7 = 15555543
1:08:18 SUBFRAME 4 WORD 8 = 15555543
1:08:18 SUBFRAME 4 WORD 9 = 15555543
1:08:18 SUBFRAME 4 WORD 10 = 15555510

1:08:18 Preamble 4    8B      hex
1:08:18 Subframe id 4    4     4 none
1:08:18 Telemetry 4   2AAA      ! hex
1:08:18 Trunc time of week 4 732C    29484 none
1:08:18 Alert flag 4    0     0 ! none
1:08:18 Anti-Spoof flag 4   0     0 ! none
1:08:18 Data 4 id     1     1 none
1:08:18 Page 4 id    3C     60 none
1:08:18 Word no  3    AAAA      ! hex
1:08:18 Word no  4   AAAAAA      ! hex
1:08:18 Word no  5   AAAAAA      ! hex
1:08:18 Word no  6   AAAAAA      ! hex
1:08:18 Word no  7   AAAAAA      ! hex
1:08:18 Word no  8   AAAAAA      ! hex
```


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```
1:08:18 Word no  9   AAAAAA      ! hex
1:08:18 Word no  10   2AAAAA      ! hex

1:08:24 SUBFRAME 5 WORD 1 = 22EAAA8A
1:08:24 SUBFRAME 5 WORD 2 = 0E65A560
1:08:24 SUBFRAME 5 WORD 3 = 15800005
1:08:24 SUBFRAME 5 WORD 4 = 22BD27AB
1:08:24 SUBFRAME 5 WORD 5 = 3FFFFFFF
1:08:24 SUBFRAME 5 WORD 6 = 17BC9904
1:08:24 SUBFRAME 5 WORD 7 = 0DC3DA7B
1:08:24 SUBFRAME 5 WORD 8 = 3FFFFFFF
1:08:24 SUBFRAME 5 WORD 9 = 283E833F
1:08:24 SUBFRAME 5 WORD 10 = 3FFFFFAC

1:08:24 Preamble 5     8B      hex
1:08:24 Subframe id 5    5     5 none
1:08:24 Telemetry 5    2AAA      ! hex
1:08:24 Trunc time of week 5  732D    29485 none
1:08:24 Alert flag 5    0     0 ! none
1:08:24 Anti-Spoof flag 5   0     0 ! none
1:08:24 Data id 5     1     1 none
1:08:24 Satellite id    16     22 none
1:08:24 Alm eccentricity   0 0.0000000000E+000 none
1:08:24 Time of almanac   75 4.7923200000E+005 seconds
1:08:24 Delta inclination   B61 5.5561065674E-003 semi-c
1:08:24 Alm right asc rate   0 0.0000000000E+000 semi-c/s
1:08:24 Alm sat health    0      hex
1:08:24 Alm root semi major A10D9B 5.1537006836E+003 metres**1/2
1:08:24 Alm long asc node  370F69 4.3015778065E-001 semi-c
1:08:24 Alm arg perigee    0 0.0000000000E+000 semi-c
1:08:24 Alm mean anomaly  5F05F3 7.4236905575E-001 semi-c
1:08:24 Alm af0      0 0.0000000000E+000 seconds
1:08:24 Alm af1      0 0.0000000000E+000 s/s
```

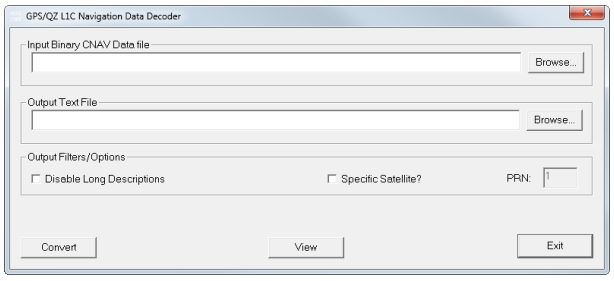
### 26.6.5 GPS/QZ L1C Nav Data Extract Utility

***Notes**:*

***1)** This utility can extract data from both GPS and QZ satellites*

***2)** Before running the scenario, select the menu item **Options-**General Options**-Dump navigation data** (page 5-15) to write navigation data files to the scenario folder*

After the scenario has finished, start the decoder by selecting **Tools-General Utilities-GPSL1C Nav Data Extract**:




| | |
|---|---|
| **Input Binary CNAV Data file** | Click **Browse…** and navigate to the file you want to use |
| **Output Text File** | Click **Browse…** and navigate to the folder where you want to store the extracted data with a filename of your choice |
| **Output Filters / Options** | |
| **Disable Long Descriptions** | Deselect (default): Output text file includes parameter descriptions<br>Select: Output text file excludes parameter descriptions |
| **Specific Satellite?** | Extract data from:<br>Deselect (default): all satellites (GPS and QZ)<br>Select: use a specific satellite - type its PRN in **Satellite PRN** |


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| | |
|---|---|
| **Convert** | Click to begin the extraction |
| **View** | Click to view the extracted output file |

The decoder outputs text and hexadecimal values. If the hexadecimal value is not from the limited set defined in paragraph 3.5.4.5 of reference ee), the data is bracketed; see the example listing below:

```
TEXT_PAGE    : 0
TEXT_MESSAGE  : Test text message for page: 0
TEXT_MSG_AS_HEX : 54 (65)(73)(74) 20 (74)(65)(78)(74) 20
(6d)(65)(73)(73)(61)(67)(65) 20 (66)(6f)(72) 20 (70)(61)(67)(65) 3a 20 30
CRC Checksum : 0xaec533
```

### 26.6.5.1.1 Command line parameters

***Note**: This section uses the same syntax as the remote commands in reference qq)*

You can run the **L1C Nav Data Extract** utility from the command line using these parameters:

| | | | |
|---|---|---|---|
| **Command** | L1C_decoder.exe “-infile” <infile> “-outfile” <outfile> “-longdesc” <longdesc> [“-satprn” <satprn>] “-qz” <qz> “-autorun” <autorun> | | |
| **Where** | infile | ::= | The location of the input binary CNAV file for decoding. You must specify the full path and file name in inverted commas. |
| | outfile | ::= | The location of the decoded output file. You must specify the full path and file name in inverted commas |
| | longdesc | ::= | “no” (Do not provide a description of each parameter in the output file)<br>\|<br>“yes” (Provide a description of each parameter in the output file) |
| | satprn | ::= | (PRN) \| ((blank)\|[leave out parameter])<br>“(PRN)”<br>Decode data from this PRN only<br>“(blank)\|[leave out parameter]”<br>Decode data from all satellites (see example) |
| | qz | ::= | “no” (Decode data from GPS satellites only)<br>\|<br>“yes” (Decode data from QZ satellites only) |
| **Where (cont)** | autorun | ::= | “no” (Loads the utility with the infile and outfile you specify in the command line. Does not automatically run the utility.)<br>\|<br>“yes” (Loads the utility with the infile and outfile you specify in the command line. Automatically runs the utility. The utility exits after decoding the infile.) |


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**Examples**

Automatically run the utility from the command line using this input file *C:\Program Files\Spirent Communications\Positioning Application\Scenarios\scenario1 \foo.bin*, and save the output file as*…\Positioning Application\Scenarios \scenario1\foo_decoded.txt,*
Do not use long descriptions. Decode data from all satellites. Decode data only from GPS satellites

L1C_decoder.exe -infile "C:\Program Files
\Spirent Communications\Positioning Application\Scenarios
\scenario1\foo.bin" -outfile "C:\Program Files\Spirent Communications\Positioning Application\Scenarios\scenario1
\foo_decoded.txt" –longdesc no -satprn –qz no -autorun yes

OR (with <satprn> left out):

L1C_decoder.exe -infile "C:\Program Files
\Spirent Communications\Positioning Application\Scenarios
\scenario1\foo.bin" -outfile "C:\Program Files\Spirent Communications\Positioning Application\Scenarios\scenario1
\foo_decoded.txt" –longdesc no –qz no -autorun yes

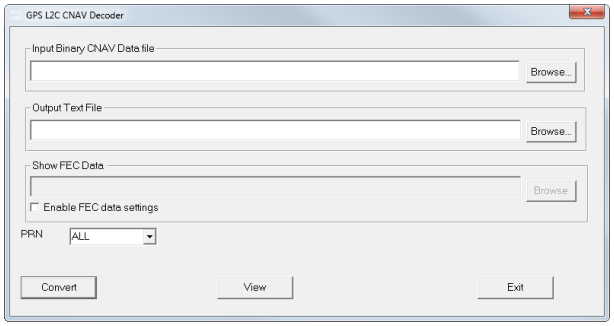
## 26.6.6 GPS L2C / L5 Nav Data Extract

***Notes**:*

***1)** Since GPS L2C/L5 navigation data and Quasi-Zenith navigation data both use the **.cnav* file extension and there are subtle differences in the file formats, Spirent recommends you take care when you select files for conversion.*

***2)** Before running the scenario, select the menu item **Options-**General Options **-Dump navigation data** (page 5-15) to write navigation data files to the scenario folder*

This utility extracts GPS L2C/L5 navigation data to a text file. The L2C/L5 navigation data file uses the **.cnv* extension.




After the scenario has finished, start the decoder by selecting **Tools-General Utilities-GPS L2C/L5 Nav Data Extract**:

| | |
|---|---|
| **Input Binary CNAV Data file** | Click **Browse** and navigate to the file you want to use |
| **Output Text File** | Click **Browse** and navigate to the folder where you want to store the extracted data with a filename of your choice |
| **Show FEC data** | Select **Enable FEC data settings** to enable this area, then click **Browse** to define an FEC data file, which has the extension **.fec_cnv* |
| **PRN** | Choose **ALL** or the individual PRN from the drop down |
| **Convert** | Click to begin the conversion |
| **View output file** | Click to view the decoded output file |

### 26.6.6.1 Command line parameters

***Note**: This section uses the same syntax as the remote commands in reference qq)*

You can run the **GPS L2C / L5 Nav Data Extract** utility from the command line using these parameters:


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| | | | |
|---|---|---|---|
| **Command** | cnav_decoder.exe “-infile” <infile> “-outfile” <outfile><br>“-fec” <fec> “-fec_file” <fec_file> “-prn” <prn> “-autorun” <autorun> | | |
| **Where** | infile | ::= | The location of the input binary CNAV file for decoding.<br>You must specify the full path and file name in inverted commas. |
| | outfile | ::= | The location of the decoded output file.<br>You must specify the full path and file name in inverted commas |
| | fec | ::= | “0” (the utility will not use an FEC data file)<br>\|<br>“1” (the utility uses the FEC data file you specify in <fec_file>) |
| | fec_file | ::= | The location of the FEC data file.<br>You must specify the full path and file name in inverted commas<br>Selecting <fec>=1 and <fec_file> creates an outfile containing decoded CNAV data including the symbols information for each svid. |
| | prn | ::= | ***Note**: If you omit -prn, the decoder will decode all PRNs*<br>Specify the PRN of the satellite for which you want to decode data.<br>“0” Decodes all PRNs<br>\|<br>“nn” Decodes satellite with PRN nn |
| | autorun | ::= | “0” (\| “no”)Loads the utility with the infile and outfile you specify in the command line.<br>Does not automatically run the utility.<br>\|<br>“1” (\|“yes”)<br>Loads the utility with the infile and outfile you specify in the command line.<br>Automatically runs the utility.<br>The utility exits after decoding the infile. |
| **Examples** | Automatically run the utility from the command line using this input file *C:\Program Files\Spirent Communications\Positioning Application\Scenarios\scenario1\L2C_nav.cnav* and use this FEC data file *C:\Program Files\Spirent Communications\Positioning Application\Scenarios\scenario1\L2C_FEC.fec_cnv*.<br>Decode data for satellite with PRN = 12<br>Save the output file as *…\Positioning Application\Scenarios\scenario1\L2C_decoded.txt* and exit the utility when finished.<br>cnav_decoder.exe -infile "C:\Program Files\Spirent Communications\Positioning Application \Scenarios\scenario1\L2C_nav.bin"<br>-outfile “C:\Program Files\SpirentCommunications\PositioningApplication \Scenarios\scenario1\L2C_decoded.txt"<br>-fec 1<br>-fec_file “C:\Program Files\Spirent Communications\Positioning Application \Scenarios\scenario1\L2C_FEC.fec_cnv”<br>-prn 12<br>-autorun 1<br><br>Automatically run the utility from the command line using this input file *C:\Program Files\Spirent Communications\Positioning Application\Scenarios\scenario1\L2C_nav.cnav* and use this FEC data file *C:\Program Files\Spirent Communications\Positioning Application\Scenarios\scenario1\L2C_FEC.fec_cnv*.<br>Decode data for all satellites (either omit –prn, as in this example, or use –prn 0)<br>Save the output file as *…\Positioning Application\Scenarios\scenario1\L2C_decoded.txt* and exit the utility when finished.<br>cnav_decoder.exe -infile "C:\Program Files\Spirent Communications\Positioning Application \Scenarios\scenario1\L2C_nav.bin"<br>-outfile “C:\Program Files\SpirentCommunications\PositioningApplication \Scenarios\scenario1\L2C_decoded.txt"<br>-fec 1<br>-fec_file “C:\Program Files\Spirent Communications\Positioning Application \Scenarios\scenario1\L2C_FEC.fec_cnv”<br>-autorun 1 | | |

## 26.6.7 NMEA Logging

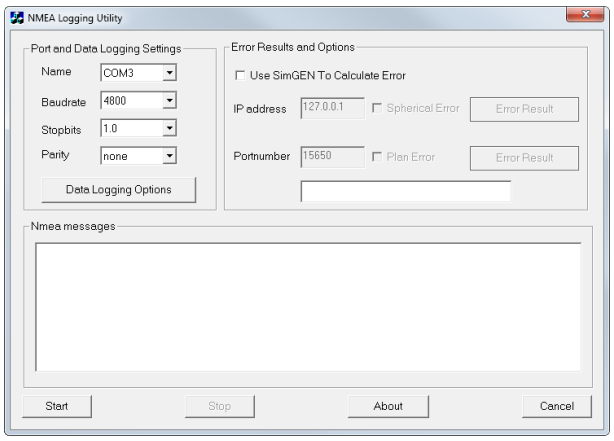
***Notes:***


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***1)*** *From SimGEN version 2-83 onward, you must connect a valid Spirent signal generator to the SimGEN Controller, or install a "no hardware" licence, to enable data logging to a file when you run any scenario in* ***No hardware ("dummy run")*** *mode.*

***2)*** *Spirent recommends you use* ***<scenario name>-Options-NMEA logging*** *(page 8-9) to log NMEA messages to a text file.*
*Spirent recommends you only use the utility Nmea_util.exe to log data to a remote PC.*

*Nmea_util.exe* is a stand-alone utility that logs NMEA data from a GPS receiver using an RS-232 connection:




The raw messages are plain text files. The messages are decoded and the data written to comma-separated variable (**.csv*) files. You can use these files to export the data to a spreadsheet or mathematical program.

First, the data is decoded to give uniformity for easier comparison and analysis. Latitude and Longitude are converted to decimal degrees before being written to the **.csv* files and time is converted to seconds from an hhmmss.ss format.

The utility records other data such as height, heading and velocity in the same format as that found in the NMEA Messages.

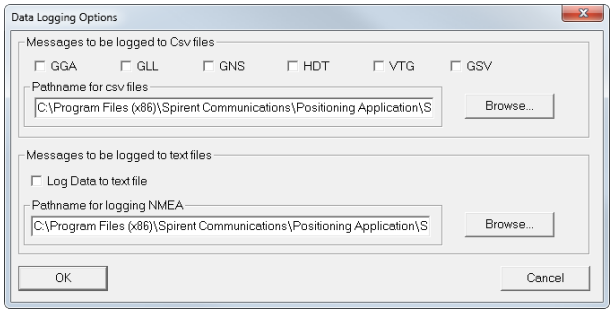
There is an option to compare logged GPS Receiver position data with the simulated position. This option displays Spherical error and Plan error (in Metres) in real-time.

Click **Start** to log NMEA messages, display these messages in the main window and log them to **.csv* and **.txt* files, depending on the options you choose.

Click **Stop** to stop logging messages. This will also kill any TCP/IP connections made to SimGEN if you are comparing receiver data and simulated data.

Click **Cancel** to terminate the utility.

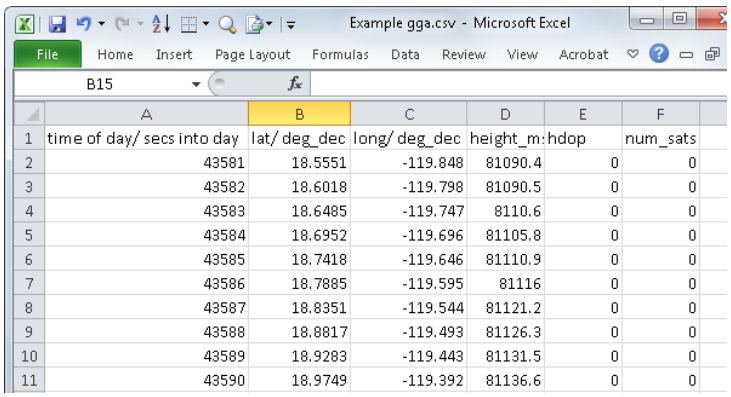
Click **Data Logging Options** to select the required NMEA messages for logging:




### 26.6.7.1 CSV file format

The utility writes **.csv* files for messages it recognises, including GGA, GLL, GNS, HDT and VTG messages. This figure shows *Example gga.csv* file.


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| | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| 1 | time of day/ secs into day | lat/ deg_dec | long/ deg_dec | height_m | hdop | num_sats |
| 2 | 43581 | 18.5551 | -119.848 | 81090.4 | 0 | 0 |
| 3 | 43582 | 18.6018 | -119.798 | 81090.5 | 0 | 0 |
| 4 | 43583 | 18.6485 | -119.747 | 8110.6 | 0 | 0 |
| 5 | 43584 | 18.6952 | -119.696 | 81105.8 | 0 | 0 |
| 6 | 43585 | 18.7418 | -119.646 | 81110.9 | 0 | 0 |
| 7 | 43586 | 18.7885 | -119.595 | 81116 | 0 | 0 |
| 8 | 43587 | 18.8351 | -119.544 | 81121.2 | 0 | 0 |
| 9 | 43588 | 18.8817 | -119.493 | 81126.3 | 0 | 0 |
| 10 | 43589 | 18.9283 | -119.443 | 81131.5 | 0 | 0 |
| 11 | 43590 | 18.9749 | -119.392 | 81136.6 | 0 | 0 |

The **.csv* files contain relevant data extracted and decoded from each message. This table shows the information that is logged to **.csv* files for each of the message types.

| Data | Message type | | | | |
|---|---|---|---|---|---|
| | GGA | GLL | GNS | HDT | VTG |
| Time of day (Seconds into day) | ✓ | ✓ | ✓ | ✓ | |
| Longitude (degrees decimal) | ✓ | ✓ | ✓ | | |
| Latitude (degrees decimal) | ✓ | ✓ | ✓ | | |
| Height (degrees decimal) | ✓ | | ✓ | | |
| Hdop | ✓ | | ✓ | | |
| Num of Satellites | ✓ | | ✓ | | |
| Heading (degrees True) | | | | ✓ | |
| Course over Ground (True) | | | | | ✓ |
| Course over Ground (Magnetic) | | | | | ✓ |
| Speed Over Ground (km/h) | | | | | ✓ |
| Speed Over Ground (Knots) | | | | | ✓ |

### 26.6.7.2 Port and data logging settings

***Note***: *SimGEN can only open COM ports up to and including COM9*

You can change the Baud rate, Parity and Stop bits settings of COM ports COM1 or COM2 to suit the NMEA settings of your GPS Receiver.

Clicking **NMEA logging-Data Logging Option** allows you to choose the messages for logging to **.csv* files (GGA, GLL, GNS, HDT or VTG). You can specify a folder for these files. By default, the folder name is that of the current scenario folder. If a valid folder is not found, the **.csv* files are written to the current scenario folder. For each of the messages chosen, it creates a *message-type.csv* file, where *message-type* refers to the type of the NMEA message chosen, for example *gga.csv*.

You can also log NMEA messages to the text file *Nmea_messages.txt*. You can also change the folder for this file, it has the same default folder as the **.csv* file default folder.

### 26.6.7.3 Error results and options

***Note**: If you are using any version of SimGEN up to PosApp version 4-00, you must select **Remote Command Settings**-Ethernet Remote Commands over TCP/UDP on Port 15650 (page 5-28). PosApp version 4-00 onwards uses Ethernet remote commands by default.*


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If SimGEN is running on your SimGEN Controller, the NMEA logging utility can compare simulated data with receiver data to give an indication of the accuracy of the receiver with respect to the simulator. You can display two Error values: Spherical Error and Plan Error.

To use the utility program to compare simulated data and receiver data, select **Use SimGEN to Calculate Error**. This utility communicates with SimGEN over a TCP/IP connection, type *"localhost"* in **IP address** and type *"15650"* in **Port number**.

If you run the NMEA logging utility on a separate PC, both the SimGEN Controller and the separate PC must have TCP/IP services enabled and be connected either:

- In the normal way, on a network using a hub, or
- Point-to-point, using a special cross-over cable

In either case, type the details of the SimGEN Controller in the **IP address** and **Port number** text boxes.

In all cases, you must enable the SimGEN remote connection BEFORE you click **Start** and the utility begins logging data.

Select the error types - **Spherical error** or **Plan error**.

### 26.6.8 NMEA to User Motion

***Notes**:*

***1)** For new applications, Spirent recommends you use an **NMEA motion file** (page 21-39). Spirent no longer supports use of this utility.*

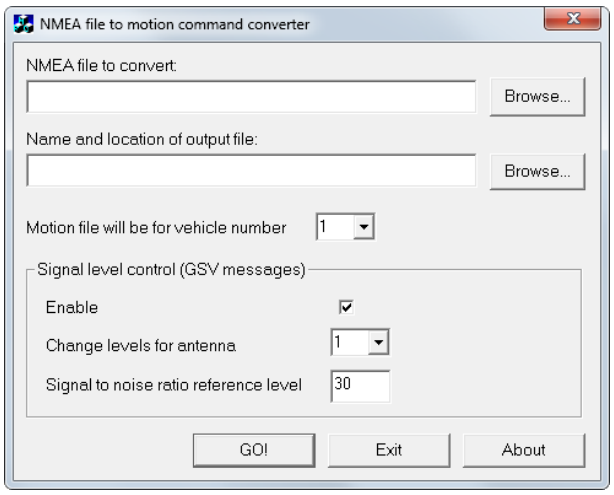
***2)** Do not specify the same file for input and output.*

You can log the motion of a GPS receiver using NMEA messages and then replay the motion in a SimGEN scenario by using this utility to translate the NMEA messages into a file of SimGEN motion and signal level commands. The generated file uses the format detailed in ***User Commands file, *.ucd*** (page 8-39).

The utility can translate motion from GGA, VTG and RMC NMEA message types using one of these combinations:

- RMC alone
- RMC and GGA
- GGA and VTG

The GSV messages provide power levels.




| | |
|---|---|
| **NMEA file to convert** | Type the NMEA filename or click **Browse** and navigate to the file |
| **Name and location of output file** | Type a name for the user command file - the utility automatically adds the **.ucd* extension. Click **Browse** and navigate to the file location you want to use |


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| | | | |
|---|---|---|---|
| **Motion file will be for vehicle number** | Select the vehicle number to which you want the motion commands to refer | | |
| | | Range: 1 to 4 | Default: 1 |
| **Signal level control (GSV messages)** | | | |
| **Enable** | **Select** (default): use signal level control<br>**Deselect**: do not use signal level control | | |
| **Change levels for antenna** | Select the antenna number to use for signal level control. This is the antenna number for the vehicle you select in **Motion file will be for vehicle number** | | |
| | | Range: 1 to 4 | Default: 1 |
| **Signal to noise ratio reference level** | Set to be the expected GSV message signal to noise ratio at the power level defined by the SimGEN source file. | | |
| | Units: decibel-Hertz | Range: -99 to 99 dB-Hz | Default: 30 |

Click **GO!** to begin the conversion.

An information window appears when conversion is complete. A window gives details any errors.

#### 26.6.8.1 Example output fragment

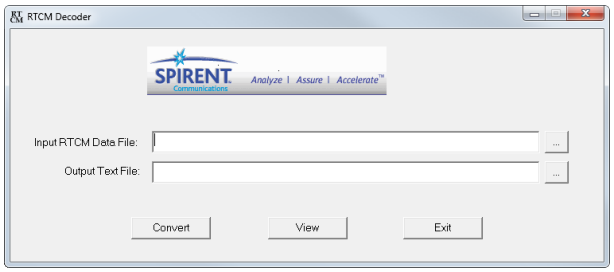
```
****** START OF MESSAGE ******
Time (s): 3.1
Channel: 1
PRN: 120
Preamble: 53 (01010011)
Message number: 1 (PRN mask assignments)
Parity: d8cd8
Message contents:
11111111 11111111 11111111 00000000 00000000 00000000 00000000 00000000
00000000 00000000 00000000 00000000 00000000 00000000 00000001 00000000
00000000 00000000 00000000 00000000 00000000 00000000 00000000 00000000
00000000 00000000 0011
GPS[ 1 ] enabled
GPS[ 2 ] enabled
GPS[ 3 ] enabled
GPS[ 4 ] enabled
GPS[ 5 ] enabled
GPS[ 6 ] enabled
GPS[ 7 ] enabled
GPS[ 8 ] enabled
GPS[ 9 ] enabled
GPS[ 10 ] enabled
GPS[ 11 ] enabled
GPS[ 12 ] enabled
GPS[ 13 ] enabled
GPS[ 14 ] enabled
GPS[ 15 ] enabled
GPS[ 16 ] enabled
GPS[ 17 ] enabled
GPS[ 18 ] enabled
GPS[ 19 ] enabled
GPS[ 20 ] enabled
GPS[ 21 ] enabled
GPS[ 22 ] enabled
GPS[ 23 ] enabled
GPS[ 24 ] enabled
GEO/WAAS/PRN[ 120 ] enabled
IODP: 3
****** END OF MESSAGE ******
****** START OF MESSAGE ******
Time (s): 4.1
Channel: 1
PRN: 120
```


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```
Preamble: 9a (10011010)
Message number: 9 (GEO navigation message)
Parity: 2ccdf4
Message contents:
00000011 00000000 01000000 00101101 11110011 01011010 01101111 01010100
10011001 11111011 10010000 00000000 00000000 00000000 00000000 00000000
00000000 00000000 00000000 00000000 00000000 00000000 00000000 00000000
00000000 00000000 0000
t0: 8 (8, 128s)
URA: 0
XG (ECEF): 16f9ad37 (385461559, 3.08369e+007m)
YG (ECEF): 2a933f72 (714293106, -2.87559e+007m)
ZG (ECEF): 0 (0, 0m)
XG rate-of-change: 0 (0, 0m/s)
YG rate-of-change: 0 (0, 0m/s)
ZG rate-of-change: 0 (0, 0m/s)
XG acceleration: 0 (0, 0m/s^2)
YG acceleration: 0 (0, 0m/s^2)
ZG acceleration: 0 (00m/s^2)
aGf0: 0 (0, 0s)
aGf1: 0 (0, 0s/s)
****** END OF MESSAGE ******
```

### 26.6.9 RTCM Decoder

This utility extracts binary RTCM data into a readable ASCII text format.




To use the utility:

→ Before running the scenario, select **Options-*General Options*-Dump navigation data** (page 5-15).

Once the scenario has finished open the utility

→ Navigate to the **Input RTCM Data File** using the **...** button.

→ Define an **Output Text File** using the **…** button.

→ Click **Convert** to convert the RTCM file to a text file.

→ Click **View** to view the text file.

### 26.6.10 SBAS Nav Data Extract utility

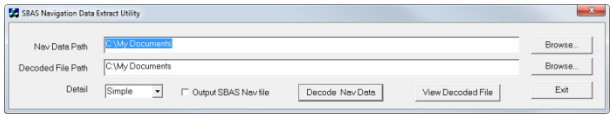
***Notes**:*

***1) Quasi-Zenith-*SAIF Nav Data Extract utility** *(page 26-57) is a variant of this utility*

***2)** Before running the scenario, select the menu item **Options-*General Options*-Dump navigation data** (page 5-15) to write navigation data files to the scenario folder*

Use this utility to decode the output file of SBAS navigation data that SimGEN produces.

SimGEN writes SBAS navigation data messages to the binary file, *waas_nav_dump.bin,* located in current scenario folder.





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Use **Browse** to navigate to the **Nav Data Path** and the **Decoded File Path** locations.

Select **Detail** from one of:

| | |
|---|---|
| **Simple** | **(default)** extracts the values and prints them in hex. |
| **Detailed** | Extracts the values and displays them in hex and decimal. Displays any scaled value. |
| **Validate** | Similar to **Detailed**, but when a valid value is a sub-set of the full range of values, SimGEN validates it and prints the test result. |

Select **Output SBAS Nav file** to produce two additional files. Depending on the number of satellites present in the binary file, the decoder produces a separate file for each satellite. The decoder includes the constellation type and the satellite PRN in the filename, as shown below:

*constellation_fec_nav_data_prnxxx.sbas_nav*

In the filename:
*constellation* refers to the name of the SBAS constellation
*prnxxx* refers to the PRN of the satellite
For example: *waas_fec_nav_data_prn123.sbas_nav*

This file contains SBAS symbols.
You can use this file as the user-defined SBAS nav file in **SBAS-*SBAS Navigation Data file*** (page 14-19)
You can use this file for instant replay.

*constellation_messages_prnxxx.sbas_hex*

In the filename:
*constellation* refers to the name of the SBAS constellation
*prnxxx* refers to the PRN of the satellite
For example: *waas_messages_prn123.sbas_hex*

This is a hex file containing the 32-byte SBAS messages defined as SBAS hex characters.
You can use this file to generate a SBAS symbols file that you can use as a user-defined SBAS nav file (**.sbas_nav*) in **SBAS-*SBAS Navigation Data file*** (page 14-19).
First, edit the **.sbas_hex* file to change the appropriate SBAS hex characters; then use the edited file with the ***SBAS FEC file generator utility*** (page 26-62) to generate a user-defined SBAS nav file, **.sbas_nav.*

***Note**: You must check this file to ensure its scenario start time corresponds to the start time in the SimGEN scenario. The time format is DD-MMM-YYYY HH:MM:SS.*

Click **Decode Nav Data** to begin the decoding process.

Click **View Decoded File** to view the file.

### 26.6.10.1 Command line parameters

***Note**: This section uses the same syntax as the remote commands in reference qq)*

You can run the **SBAS Nav Data Extract** utility from the command line using these parameters:

| | | | |
|---|---|---|---|
| **Command** | SBAS_Nav_Data_Extract_Utility.exe “-infile” <infile> “-outfile” <outfile> “-fec” <fec> “-detail” <detail> “-autorun” <autorun> | | |
| **Where** | infile | ::= | The location of the input binary CNAV file for decoding.<br>You must specify the full path and file name in inverted commas. |
| | outfile | ::= | The location of the decoded output file.<br>You must specify the full path and file name in inverted commas |


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| | | | |
|---|---|---|---|
| | fec | ::= | “0” (Do not generate a separate symbols file or hex file for the decoded data)<br>\|<br>“1” (Generate a separate symbols file (per svid) and hex char file (per svid) for the decoded data. See ***SBAS Nav Data Extract utility*** (page 26-51)) |
| | fec_file | ::= | The location of the FEC data file.<br>You must specify the full path and file name in inverted commas<br>Selecting <fec>=1 and <fec_file> creates an outfile containing decoded CNAV data including the symbols information for each svid. |
| | detail | ::= | “simple”<br>\| “detailed”<br>\| “validate”<br>See Detail parameter in ***SBAS Nav Data Extract utility***. |
| | autorun | ::= | “0” (\| “no”) (Loads the utility with the infile and outfile you specify in the command line.<br>Does not automatically run the utility.)<br>\|<br>“1” (\|“yes”) (Loads the utility with the infile and outfile you specify in the command line.<br>Automatically runs the utility.<br>The utility exits after decoding the infile.) |
| **Example** | Automatically run the utility from the command line using this input file *C:\Program Files\Spirent Communications\Positioning Application\Scenarios\scenario1 \waas_nav_dump.bin*, and save the output file as…*\Positioning Application\Scenarios \scenario1\waas_decoded.txt*,<br><br>Do not create a FEC encoded output file, extract the values and display them in hex and decimal, exit the utility when finished.<br><br>*SBAS_Nav_Data_Extract_Utility.exe -infile "C:\Program Files \Spirent Communications\Positioning Application\Scenarios \scenario1\ waas_nav_dump.bin" -outfile "C:\Program Files\Spirent Communications\Positioning Application\Scenarios\scenario1 \waas_decoded.txt" -fec 0 -detail “detailed” -autorun "yes"* | | |

## 26.6.11 Socket String Send

***Note**:*

***1)** You can check the status of the scenario at any time by typing “NULL” into the **Send** text box and clicking **Send**.*

***2)** If you are using any version of SimGEN up to PosApp version 4-00, you must select **Remote Command Settings-Ethernet Remote Commands over TCP/UDP on Port 15650** (page 5-28). PosApp version 4-00 onwards uses Ethernet remote commands by default.*

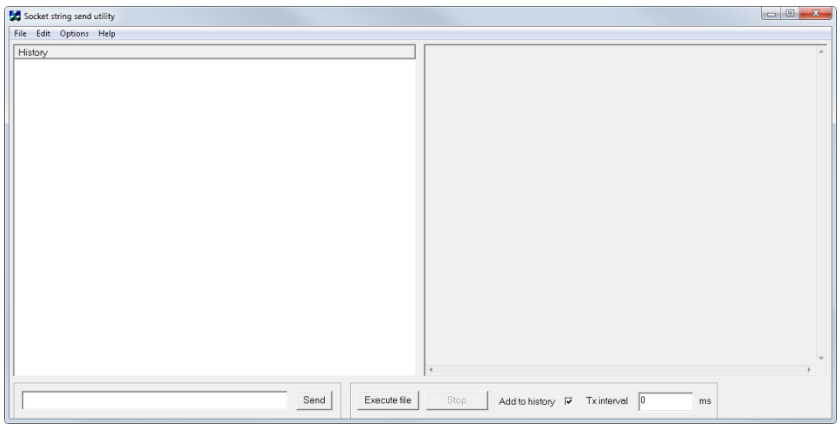
***3)** The Socket string send utility detects your signal generator and applies the correct IP address:*
*127.0.0.1 for GSS8000-series, and earlier, signal generators using the SimGEN Controller*
*192.168.25.1 for GSS9000-series signal generators using the C50r SimGEN Host*

This utility tests the SimGEN remote socket interface functionality, command operation, command syntax and so on. Run this utility from the C50r SimGEN Host (for GSSS9000-series signal generators) or the SimGEN Controller (for GSS8000-series and earlier signal generators). Reference qq) gives more details on this utility.

Run **Tools-General Utilities-*Socket String Send*** (page 26-53) and connect to the server. Alternatively, navigate to the Positioning Application folder (default location for the C50r SimGEN Host: *D:\posapp\software\<version>\gui*; and for the SimGEN Controller: *C:\Program Files\Spirent Communications\Positioning Application*) and double-click on the file *socket string send.exe*.

The SimGEN ***System Messages*** window (page 3-15) displays a message when it makes the connection and displays other messages relating to the socket connection.


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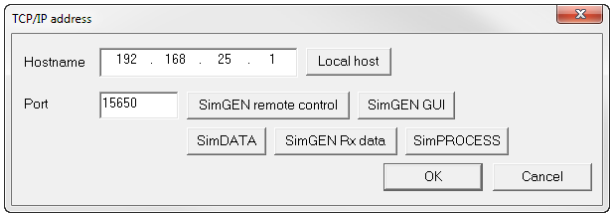



Type commands in the **Send** text box at the bottom left-hand side of the interface. Click **Send** to send the command. The left-hand area shows commands you have sent and the right-hand area shows responses from SimGEN.

This table details SimGEN status numbers.

| Status number | Description |
|---|---|
| 0 | No scenario specified |
| 1 | Loading |
| 2 | Ready |
| 3 | Arming |
| 4 | Armed |
| 5 | Running |

Click on **Options-TCP/IP address…** to set the default IP address using this dialog, which shows **Hostname** for a GSS9000-series signal generator:




**Port** shows the port number - click on the relevant button to enter the port you want to use.

## 26.6.12 Quasi-Zenith utilities

These utilities are similar to the GPS and SBAS navigation data extract utilities.

Before using these utilities, you must select the menu item **Options-*General Options*-Dump navigation data** (page 5-15) to write Quasi-Zenith navigation data messages to a binary file, *qz_nav_dump.bin,* located in current scenario folder.

### 26.6.12.1 L1C/A Navigation Data Extract utility

***GPS L1C/A Nav Data Extract*** (page 26-36) details using this utility.

### 26.6.12.2 GPS/QZ L1C Nav Data Extract Utility

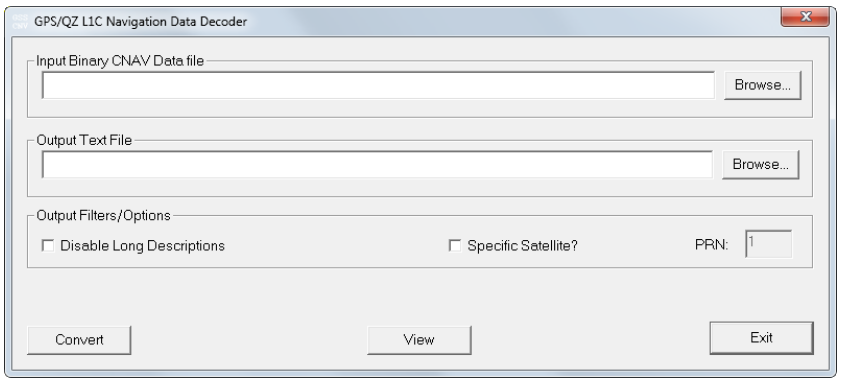
***Notes**:*

***1)** This utility can extract data from both GPS and QZ satellites*

***2)** Before running the scenario, select the menu item **Options-*General Options*-Dump navigation data** (page 5-15) to write navigation data files to the scenario folder*

After the scenario has finished, start the decoder by selecting **Tools-General Utilities-L1C Nav Data Extract**:


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| | |
|---|---|
| **Input Binary CNAV Data file** | Click **Browse…** and navigate to the file you want to use |
| **Output Text File** | Click **Browse…** and navigate to the folder where you want to store the extracted data with a filename of your choice |
| **Output Filters / Options** | |
| **Disable Long Descriptions** | Deselect (default): Output text file includes parameter descriptions<br>Select: Output text file excludes parameter descriptions |
| **Specific Satellite?** | Extract data from:<br>Deselect (default): all satellites (GPS and QZ)<br>Select: use a specific satellite - type its PRN in **Satellite PRN** |
| **Convert** | Click to begin the extraction |
| **View** | Click to view the extracted output file |

### 26.6.12.2.1 Command line parameters

***Note**: This section uses the same syntax as the remote commands in reference qq)*

You can run the **L1C Nav Data Extract** utility from the command line using these parameters:

| | | | |
|---|---|---|---|
| **Command** | L1C_decoder.exe “-infile” <infile> “-outfile” <outfile> “-longdesc” <longdesc> [“-satprn” <satprn>] “-qz” <qz> “-autorun” <autorun> | | |
| **Where** | infile | ::= | The location of the input binary CNAV file for decoding. You must specify the full path and file name in inverted commas. |
| | outfile | ::= | The location of the decoded output file. You must specify the full path and file name in inverted commas |
| | longdesc | ::= | “no” (Do not provide a description of each parameter in the output file)<br>\|<br>“yes” (Provide a description of each parameter in the output file) |
| | satprn | ::= | (PRN) \| ((blank)\|[leave out parameter])<br>“(PRN)”<br>Decode data from this PRN only<br>“(blank)\|[leave out parameter]”<br>Decode data from all satellites (see example) |
| | qz | ::= | “no” (Decode data from GPS satellites only)<br>\|<br>“yes” (Decode data from QZ satellites only) |


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| | | | |
|---|---|---|---|
| **Where (cont)** | autorun | ::= | "no" (Loads the utility with the infile and outfile you specify in the command line.<br>Does not automatically run the utility.)<br>\|<br>"yes" (Loads the utility with the infile and outfile you specify in the command line.<br>Automatically runs the utility.<br>The utility exits after decoding the infile.) |
| **Examples** | Automatically run the utility from the command line using this input file *C:\Program Files\Spirent Communications\Positioning Application\Scenarios\scenario1\foo.bin*, and save the output file as…*\Positioning Application\Scenarios\scenario1\foo_decoded.txt,*<br>Do not use long descriptions. Decode data from all satellites. Decode data only from QZ satellites<br><br>L1C_decoder.exe -infile "C:\Program Files\Spirent Communications\Positioning Application\Scenarios\scenario1\foo.bin" -outfile "C:\Program Files\Spirent Communications\Positioning Application\Scenarios\scenario1\foo_decoded.txt" –longdesc no -satprn –qz yes -autorun yes<br><br>OR (with <satprn> left out):<br><br>L1C_decoder.exe -infile "C:\Program Files\Spirent Communications\Positioning Application\Scenarios\scenario1\foo.bin" -outfile "C:\Program Files\Spirent Communications\Positioning Application\Scenarios\scenario1\foo_decoded.txt" –longdesc no –qz yes -autorun yes | | |

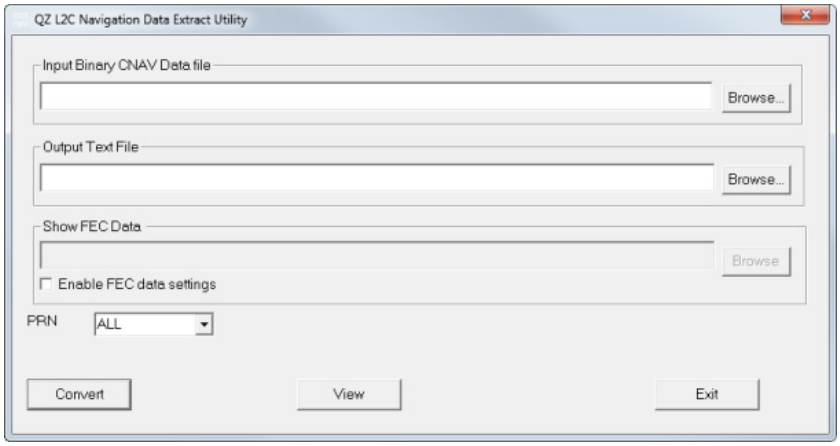
### 26.6.12.3 L2/L5 CNAV Navigation Data Extract Utility

***Notes**:*

***1)** Since GPS L2C/L5 navigation data and Quasi-Zenith navigation data both use the *.cnav file extension and there are subtle differences in the file formats, Spirent recommends you take care when you select files for conversion*

***2)** Before running the scenario, select the menu item **Options-**General Options**-Dump navigation data** (page 5-15) to write navigation data files to the scenario folder*

This utility extracts data from a Quasi-Zenith L2C/L5 navigation data file (*.cnv) to a text file. After the scenario has finished, start the decoder by selecting **Tools-General Utilities-QZ Utilities L2C/L5 Nav Data Extract**




| | |
|---|---|
| **Input Binary CNAV Data file** | Click **Browse** and navigate to the Quasi-Zenith navigation data file you want to use. |
| **Output Text File** | Click **Browse** and navigate to the folder where you want to store the extracted data with a filename of your choice |
| **Show FEC data** | Currently not in useSelect **Enable FEC data settings** to enable this area, then click **Browse** to define an FEC data file, which has the extension **.fec_cnv* |


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| | |
|---|---|
| ***Note**: The simulated Quasi-Zenith signals apply FEC for L2, but SimGEN does not currently generate a navigation data dump file in symbol format.*<br>*Only the original navigation data bit stream for QZ L2C is written to file.* | |
| **Convert** | Click to begin the conversion |
| **View output file** | Click to view the decoded output file |

#### 26.6.12.4 Command line parameters

***Note**: This section uses the same syntax as the remote commands in reference qq)*

You can run the **Quasi Zenith L2C / L5 Nav Data Extract** utility from the command line using these parameters:

| | | | |
|---|---|---|---|
| **Command** | cnav_decoder.exe “-infile” <infile> “-outfile” <outfile><br>“-qz” <qz> “-autorun” <autorun> | | |
| **Where** | infile | ::= | The location of the input binary CNAV file for decoding.<br>You must specify the full path and file name in inverted commas. |
| | outfile | ::= | The location of the decoded output file.<br>You must specify the full path and file name in inverted commas |
| | qz | ::= | “0” (Decode GPS navigation data files)<br>\|<br>“1” (Decode Quasi-Zenith navigation data files<br>If you omit this parameter, the utility assumes a GPS navigation data file and Quasi-Zenith conversion errors could result) |
| | autorun | ::= | “0” (\| “no”) (Loads the utility with the infile and outfile you specify in the command line.<br>Does not automatically run the utility.)<br>\|<br>“1” (\|“yes”) (Loads the utility with the infile and outfile you specify in the command line.<br>Automatically runs the utility.<br>The utility exits after decoding the infile.) |
| **Example** | Automatically run the utility from the command line using this Quasi-Zenith input file *C:\Program Files\Spirent Communications\Positioning Application\Scenarios\scenario1\L2C_nav.cnav*<br>*C:\Program Files\Spirent Communications\Positioning Application\Scenarios\scenario1\L2C_FEC.fec_cnv*.<br>Save the output file as *…\Positioning Application\Scenarios\scenario1\L2C_decoded.txt* and exit the utility when finished.<br>cnav_decoder.exe -infile "C:\Program Files\Spirent Communications\Positioning Application\Scenarios\scenario1\L2C_nav.cnav"<br>-outfile “C:\Program Files\SpirentCommunications\Positioning Application\Scenarios\scenario1\L2C_decoded.txt" -qz “1” -autorun “1” | | |

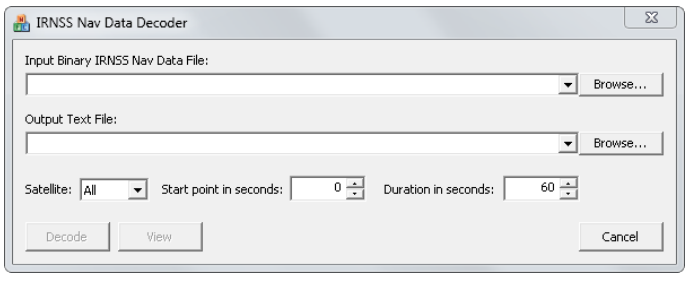
#### 26.6.12.5 SAIF Nav Data Extract utility

***SBAS Nav Data Extract utility*** (page 26-51) details using this utility.

### 26.6.13 IRNSS Nav Data Extract utility

***Note**: Before running the scenario, select the menu item **Options-General Options-Dump navigation data** (page 5-15) to write navigation data files to the scenario folder*

The utility, shown in the figure below, extracts data from an IRNSS S-band/L5 navigation data file (**.inv*) to a text file.





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After the scenario has finished, start the decoder by selecting the menu item **Tools-General Utilities-IRNSS S-band/L5 Nav Data Extract**.

| | | | |
|---|---|---|---|
| **Input Binary IRNSS Nav Data file** | Click **Browse** and navigate to the IRNSS data file (**.inv*) you want to decode. | | |
| **Output Text File** | Click **Browse** and navigate to the folder where you want to store the extracted data with a filename of your choice | | |
| ***Note**: Currently SimGEN does not generate navigation data dump files for IRNSS S-band/L5 *.inv files after applying FEC* | | | |
| **Satellite** | Select the satellite or select **All**<br>If you select **All**, the utility writes one file of decoded data for each satellite to the folder you selected in **Output text file** | | |
| **Start point in seconds** | Type or select the start point of the data | | |
| | Units: integer seconds | Range: 0 to 86 400 s | Default: 0 |
| **Duration in seconds** | Type or select the duration | | |
| | Units: integer seconds | Range: 0 to 86 400 s | Default: 60 |
| **Decode** | Click to decode the **Input Binary IRNSS Nav Data file** | | |
| **View** | Click to view the decoded file in a text editor | | |

### 26.6.13.1 Command line parameters

***Note**: This section uses the same syntax as the remote commands in reference qq)*

You can run the **IRNSS S-band/L5 Nav Data Extract** utility from the command line using these parameters:

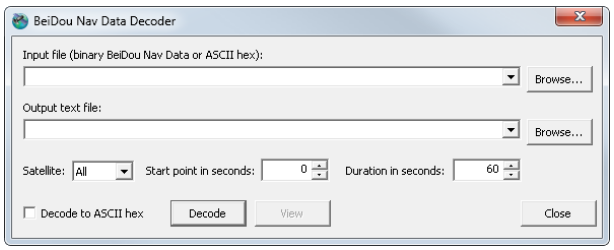
| | | | |
|---|---|---|---|
| **Command** | IRNSS_Nav_Data_Decoder_App.exe “-infile” <infile> “-outfile” <outfile> “-svid” <svid> “-start” <start> “-duration” <duration> “-autorun” <autorun> | | |
| **Where** | infile | ::= | The location of the input binary file for decoding.<br>You must specify the full path and file name in inverted commas. |
| | outfile | ::= | The location of the decoded output file.<br>You must specify the full path and file name in inverted commas<br>If you use -sat “All”, the utility writes one file of decoded data for each satellite to the location of the decoded output file |
| | sat | ::= | “0-32” (Extracts data from this satellite SVID)<br>\|<br>“All” (Extracts data from every satellite) |
| | start | ::= | “0-86400” (Start decoding at, seconds) |
| | duration | ::= | “0-86400” (Duration of data to decode, seconds) |
| | autorun | ::= | “0” (\| “no”) (Loads the utility with the infile and outfile you specify in the command line.<br>Does not automatically run the utility.)<br>\|<br>“1” (\|“yes”) (Loads the utility with the infile and outfile you specify in the command line.<br>Automatically runs the utility.<br>The utility exits after decoding the infile.) |

## 26.6.14 BeiDou Nav Data Extract utility

***Note**: Before running the scenario, select the menu item **Options-**General Options**-Dump navigation data** (page 5-15) to write navigation data files to the scenario folder*

The utility, shown in the figure below, extracts data from BeiDou B1 and B2 navigation data files (**.BD1* and **.BD2*) to a text file, with an option to extract B1 data to an ASCII hexadecimal file.


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After the scenario has finished, start the decoder by selecting the menu item **Tools-General Utilities-BeiDou D1/D2 Nav Data Extract**.

| | | | |
|---|---|---|---|
| **Input Binary BeiDou Nav Data file** | Click **Browse…** and navigate to the BeiDou navigation data file (**.BD1* or **.BD2*) you want to decode. ***Navigation data source file format*** (page 18-18) describes the BeiDou navigation data files. | | |
| **Output Text File** | Click **Browse…** and navigate to the folder where you want to store the extracted data, as an ASCII text file, with a filename of your choice. | | |
| **Satellite** | Select the satellite or select **All**<br>If you select **All**, the utility writes one file of decoded data for all satellites to the folder you selected in **Output text file** | | |
| **Start point in seconds** | Type or select the start point of the data to decode | | |
| | Units: integer seconds | Range: 0 to 86 400 s | Default: 0 |
| **Duration in seconds** | Type or select the duration of the data to decode | | |
| | Units: integer seconds | Range: 0 to 86 400 s | Default: 60 |
| **Dump to hex** | Deselect (default): Does not create a hexadecimal format file<br>Select: Creates an ASCII hexadecimal format file from the B1 data **Input Binary BeiDou Nav Data file** you choose. This filename has the format *[satellite].B1_nav*, where *[satellite]* is the **Satellite** you chose.<br>If you select **Satellite-All**, the utility writes one ASCII hexadecimal file per satellite.<br>The utility saves the hexadecimal files to the folder you select in **Output Text File**.<br>The utility creates the ASCII hexadecimal file in addition to the ASCII text file. | | |
| **Decode** | Click to decode the **Input Binary BeiDou Nav Data file** | | |
| **View** | Click to view the decoded file in a text editor | | |

In addition, this utility can decode ASCII hexadecimal files to text with the following restrictions:

- → D1 files must contain 75 ASCII hexadecimal characters per line
- → D2 files must contain 750 ASCII hexadecimal characters per line
- → The utility treats any line starting with "!" as a comment line
- → The utility will not process lines containing characters outside the hexadecimal range ('0' to '9', 'A' to 'F', or 'a' to 'f', all inclusive)

### 26.6.14.1 Command line parameters

***Note**: This section uses the same syntax as the remote commands in reference qq)*

You can run the **BeiDou D1/D2 Nav Data Extract** utility from the command line using these parameters:

| | | | |
|---|---|---|---|
| **Command** | BeiDou_Nav_Data_Decoder_App.exe "-infile" <infile> "-outfile" <outfile> "-svid" <svid> "-start" <start> "-duration" <duration> "-hex" <hex> "-autorun" <autorun> | | |
| **Where** | infile | ::= | The location of the input binary file for decoding.<br>You must specify the full path and file name in inverted commas. |


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| | | |
|---|---|---|
| outfile | ::= | The location of the decoded output file.<br>You must specify the full path and file name in inverted commas<br>If you use -sat “All”, the utility writes one file of decoded data for each satellite to the location of the decoded output file |
| svid | ::= | “0-32” (Extracts data from this satellite SVID)<br>\|<br>“All” (Extracts data from every satellite) |
| start | ::= | “0-86400” (Start decoding at, seconds) |
| duration | ::= | “0-86400” (Duration of data to decode, seconds) |
| hex | ::= | “0” (\|”no”) (does not produce an ASCII hexadecimal file)<br>\|<br>“1” (\|“yes”) (produces an ASCII hexadecimal file |
| autorun | ::= | “0” (\| “no”) (Loads the utility with the infile and outfile you specify in the command line.<br>Does not automatically run the utility.)<br>\|<br>“1” (\|“yes”) (Loads the utility with the infile and outfile you specify in the command line.<br>Automatically runs the utility.<br>The utility exits after decoding the infile.) |

| | |
|---|---|
| **Example** | Automatically run the utility from the command line using this BeiDou input file *C:\Program Files\Spirent Communications\Positioning Application\Scenarios\scenario1\nav_data.BD1 C:\Program Files\Spirent Communications\Positioning Application\Scenarios\scenario1\L2C_FEC.fec_cnv*.Use satellite 2, starting at 10 seconds for a duration of 100 seconds and extract ASCII hexadecimal data.<br>Save the output file as *…\Positioning Application\Scenarios\scenario1\ nav_data.txt* and exit the utility when finished.<br>BeiDou_Nav_Data_Decoder_App.exe -infile "C:\Program Files\Spirent Communications \Positioning Application\Scenarios\scenario1\nav_data.BD1" -outfile “C:\Program Files\SpirentCommunications\Positioning Application\Scenarios \scenario1\ nav_data.txt” -svid “2” -start “10” -duration “100” -hex “1” -autorun “1” |

| | |
|---|---|
| **Example** | Automatically run the utility from the command line using this IRNSS input file *C:\Program Files\Spirent Communications\Positioning Application\Scenarios\scenario1\nav_data.inv C:\Program Files\Spirent Communications\Positioning Application\Scenarios\scenario1\L2C_FEC.fec_cnv*.Use satellite 2, starting at 10 seconds for a duration of 100 seconds.<br>Save the output file as *…\Positioning Application\Scenarios\scenario1\ nav_data.txt* and exit the utility when finished.<br>IRNSS_Nav_Data_Decoder_App.exe -infile "C:\Program Files\Spirent Communications \Positioning Application\Scenarios\scenario1\nav_data.inv" -outfile “C:\Program Files\SpirentCommunications\Positioning Application\Scenarios \scenario1\ nav_data.txt” -svid “2” -start “10” -duration “100” |

### 26.6.15 SimROUTE

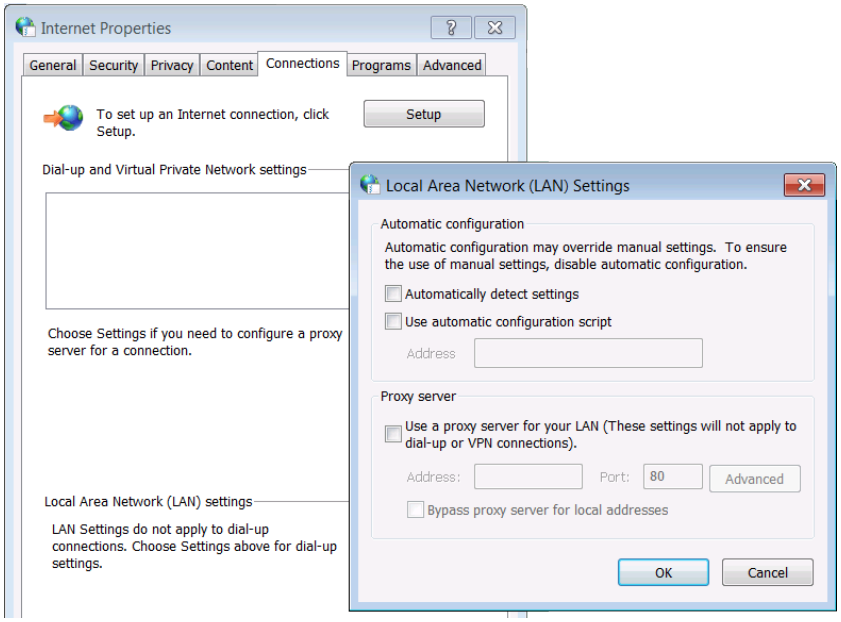
***Licenced feature**: You will need a licence to use this feature. Contact Spirent for licencing details*

***Note**: You must connect your signal generator to the internet to use SimROUTE. The status bar indicates ‘Online’ if SimGEN connects to the internet at the time it starts.*

***Note for all users:** Currently, in order for Google Maps to update properly, you must disable auto detection of proxies.*

*Click **Start-Control Panel-Internet Options-Internet Properties-Connections-LAN Settings** and deselect **Automatically detect settings** as in this figure:*


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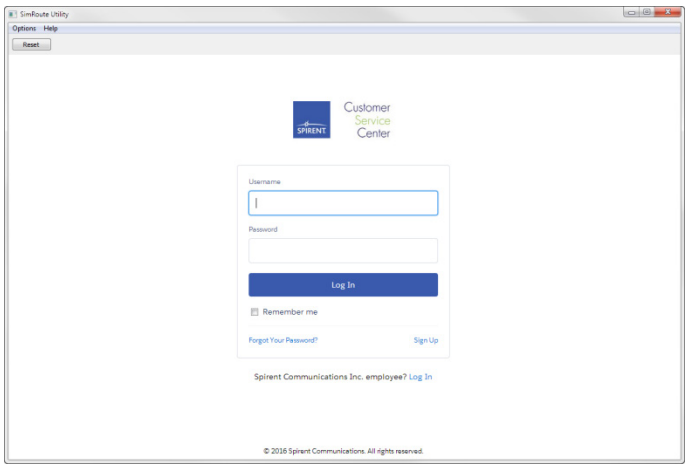

*Click **OK***

Reference zzz) describes using SimROUTE to create a trajectory for vehicle motion.

SimROUTE creates a user motion file (**.umt*) that you use in **Vehicle-Motion-*User motion files*** (page 21-38)

To use SimROUTE, click on **Tools-General Utilities-SimROUTE Utility**.

The SimROUTE Utility opens on the Spirent CSC log-in page (or use this link : support.spirent.com/SpirentCSC/login?inst=o)



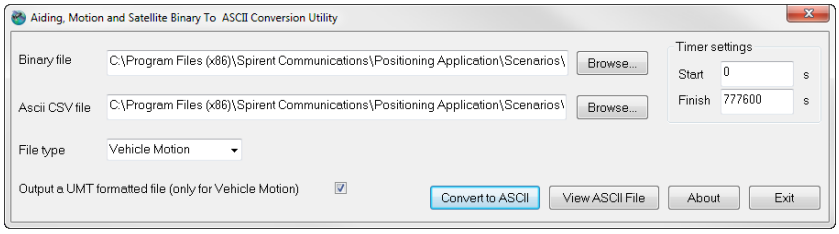

Enter your details and navigate to the SimROUTE page. Follow the details in reference zzz) to generate your route.

The ***Map window*** (page 3-14) shows a map of the route you generated using SimROUTE with your vehicle's progress during the scenario.

## 26.7 Binary to ASCII file conversion utility

***Note**: See reference qq) for details on the format of the remote commands and timestamp*


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The default location for this utility is *C:\Program Files\Spirent Communications\Positioning Application.*

To run this utility, use Windows explorer to navigate to this folder and double-click on *Binary_To_Ascii_File_Conversion_Utility.exe.*

| | | | |
|---|---|---|---|
| **Browse…** | Click and navigate to the folder where the file you want to convert is located, and to navigate to the folder where you want to store the converted file. | | |
| **File type** | select from:<br>**Vehicle Motion** (default)<br>**Aiding**<br>**Satellite** | | |
| **Output a UMT formatted file (only for Vehicle Motion)** | When you select **File Type-Vehicle Motion**:<br>select (default): to output a UMT formatted file. This file has the same name as the ASCII formatted Motion file, but uses the extension **.csv_umt*<br>deselect: does not output a UMT formatted file | | |
| **Timer settings** | You can set timers to **Start** and **Finish** conversion after the number of seconds you enter | | |
| | Units: integer seconds | Range: 0 to 777 600 seconds | Defaults:<br>**Start**: 0<br>**Finish**: 777 600 |
| **Convert to ASCII** | Click to begin file conversion | | |
| **View ASCII File** | Click to view file after conversion | | |

## 26.8 Change hardware configuration

See the menu item **Options-*Change Hardware Configuration*** (page 5-18).

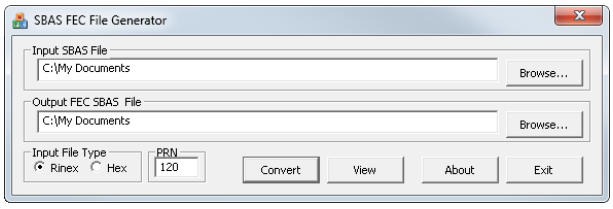
## 26.9 Hardware keys...

See the menu item **Tools-*Hardware keys*** (page 5-41).

## 26.10 SBAS FEC file generator utility

***Note**: You must generate a separate output file for each PRN you define in the scenario.*

The **SBAS FEC File Generator** utility produces an ASCII file suitable for using in the SimGEN SBAS constellation. You can use this ASCII file when you have selected **SBAS constellation-Signal sources-Signal control-Per satellite-General-Use nav data file**.




The **SBAS FEC File Generator** utility is located in C:*Program Files\Spirent Communications \Positioning Application.*


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**Input SBAS file** - click **Browse** and navigate to the **.sbas_hex* file. The input file can be of two types:

1) A standard SBAS Rinex file. Reference i) describes the SBAS Rinex file format.

2) A hex file containing a message ID and the 32-byte non-FEC encoded SBAS message, defined as hex characters. ***SBAS Nav Data Extract utility*** (page 26-51) details generating this file.
***Note:*** *The last six bits of the 32-byte message are not used.*

**Output FEC SBAS File** - click **Browse** to navigate to the location where you want the output file (**.sbas_nav*) to be stored.

**Input File Type** - select **RINEX** or **Hex**.

**PRN** - Type the PRN for the output file.

Click **Convert** to convert the Input SBAS file. This utility uses the same convolution encoding as used by SimGEN to convert the SBAS messages into symbols which are formatted; that is, 500 bits of Nav data written as 125, 4-bit hex characters.

Click **View** to view the Output FEC SBAS file in a text editor.

The following code gives an example of the file format:

```
! FEC SBAS Messages from SBAS Decoder

Scenario start time : 01-May-2003 00:00:00

120
2  53 09 c0 00 00 00 00 00 00 00 00 00 00 00 00
  00 00 00 00 00 03 77 3b 7b b8 7b 77 a1 b0 65 20

121
2  53 09 c0 00 00 00 00 00 00 00 00 00 00 00 00
  00 00 00 00 00 03 77 3b 7b b8 7b 77 a1 b0 65 20
.
.
```

Where:

Line 1 - comment (optional) starts with an exclamation mark

Line 2 - Scenario start time

Line 3 - PRN (120)

Line 4 - Message type (2) followed by 32 hexadecimal characters (32-byte SBAS message)

Line 5 - PRN (121) ... and so on

## 26.11 SimGEN2KML utility

***Note****: This section assumes you have downloaded and installed Google Earth®*

This utility works with SimGEN and Google Earth® to display the real-time position of a simulated vehicle using the Keyhole Markup Language (KML). Reference jjjj) is a link to a KML tutorial.

You can run SimGEN, SimGEN2KML and Google Earth® on the same computer or three separate computers.

SimGEN2KML uses the data-streaming output from SimGEN. As SimGEN2KML listens for data from SimGEN and for requests from Google Earth® you do not have to close the utility between running different scenarios.

To use the SimGEN2KML utility:

→ Run SimGEN.

→ Load the scenario that gives the vehicle and its trajectory, or route, you want to show on Google Earth®.

→ Select the motion file you want to use. You can use any motion source, such as ***User motion files*** (page 21-38); or you can create a motion model within SimGEN, using a vehicle command file, for example, **Aircraft-*Command file*** (page 21-10).

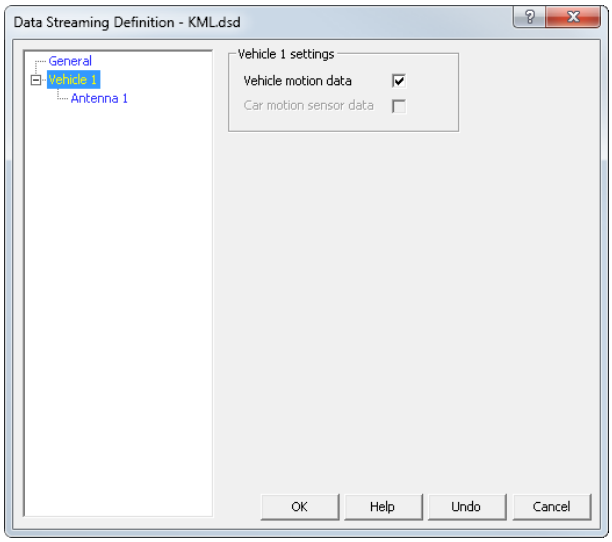
→ In SimGEN, open the data streaming definition file by double-clicking **Options-Data streaming definition file**. ***Data streaming definition file*** (page 8-6) describes this dialog.


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→ For GSS9000-series signal generators: If you are running SimGEN2KML on the C50r SimGEN Host, click **Loopback** to enter the loopback IP Address 192.168.25.1; otherwise, enter the IP address of the PC running SimGEN2KML

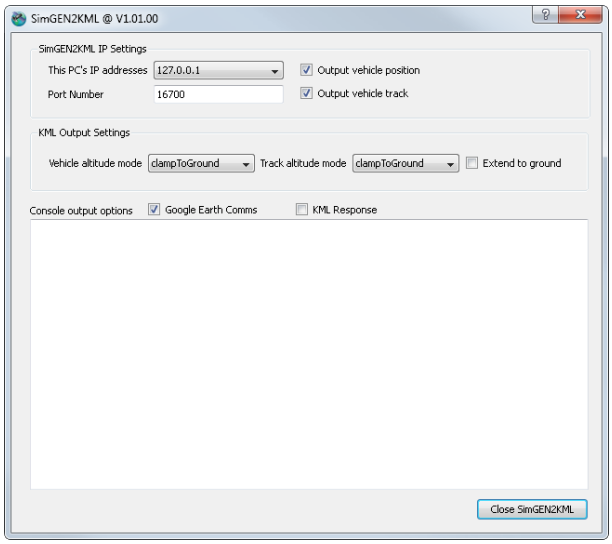
→ For GSS8000-series and earlier, signal generators: If you are running SimGEN2KML on the SimGEN Controller, click **Loopback** to enter the loopback IP Address 127.0.0.1; otherwise, enter the IP address of the PC running SimGEN2KML

→ In **Options-Data streaming definition file** select **Vehicle 1-Vehicle motion data** to output data from vehicle 1:




→ Click **OK**

Now start the SimGEN2KML utility by double-clicking …*Positioning Application/SimGEN2KML/SimGEN2KML.exe*. This figure shows the SimGEN2KML utility:



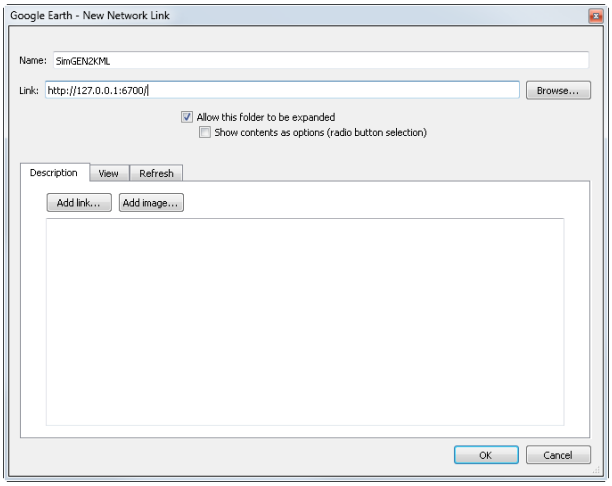

| **SimGEN2KML IP Settings** | |
|---|---|
| **This PC's IP address** | Select the network IP address for SimGEN2KML to listen for Google Earth® messages. You must ensure the network IP address you select is accessible by the PC running Google Earth®.<br>For GSS9000-series signal generators: If you use the C50r SimGEN Host to run SimGEN2KML and Google Earth®, select the loopback address 192.168.25.1<br>For GSS8000-series, and earlier, signal generators: If you use the SimGEN Controller to run SimGEN2KML and Google Earth®, select the loopback address 127.0.0.1. |


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| | |
|---|---|
| **Port Number** | Default port is **16700**, type the port number you want to use |
| **Output vehicle position** | Select (default): Displays a vehicle icon at the current position<br>Deselect: Does not display a vehicle icon at the current position |
| **Output vehicle track** | Select (default): Displays the vehicle track from the start to the current position<br>Deselect: Does not display the vehicle track |
| **KML Output Settings** | For details on these settings see https://developers.google.com/kml/documentation/altitudemode. Spirent recommends you use the default setting **clampToGround** |
| **Vehicle altitude mode** | (default) **clampToGround** |
| **Track altitude mode** | (default) **clampToGround** |
| **Extend to ground** | Deselect (default): does not extend the vehicle track to the ground<br>Select: Extends the vehicle track to the ground |
| **Console output options** | Spirent recommends you use the default settings |
| **Google Earth Comms** | Select: shows Google Earth® data at the update rate you set in **Google Earth-New Network link-Refresh** (see below) |
| **KML Response** | Select: shows the KML response at the update rate you set in **Google Earth-New Network link-Refresh** (see below) |

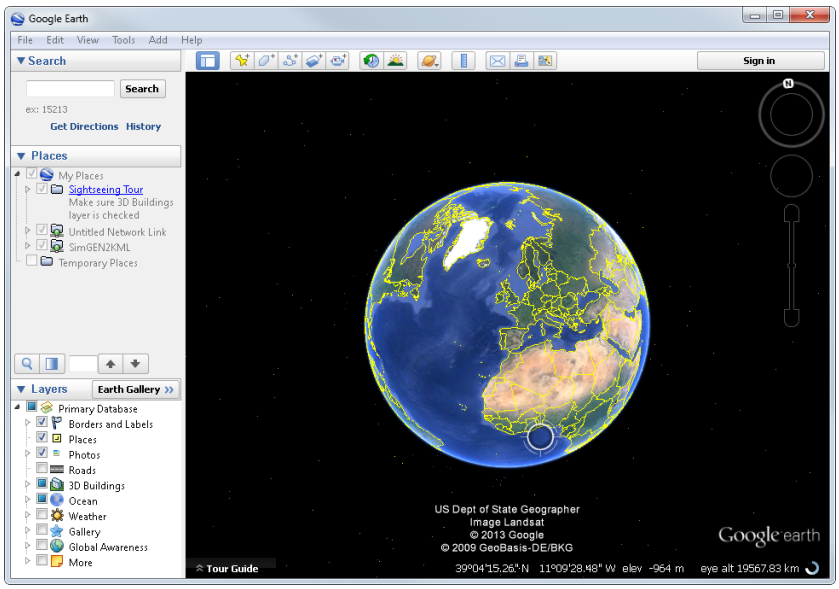
Now run Google Earth®

→ Click the Google Earth® menu item **Add-Network Link**:




→ In the Name text box, type “SimGEN2KML”. This name appears in the Places area in the Google Earth® sidebar, see the following figure. Select this name to re-use the same settings.


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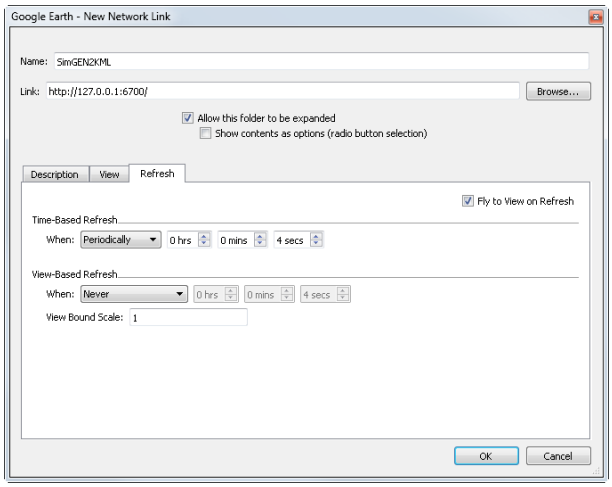

→ In the **Link** text box, type the IP Address of the PC running SimGEN2KML preceded with 'http://'.
For GSS8000-series and earlier, signal generators:
If you are running Google Earth® and SimGEN2KML on the SimGEN Controller, type '*http://127.0.0.1*', which is the SimGEN Controller loopback address preceded with 'http://'.
For GSS9000-series signal generators
If you are running Google Earth® and SimGEN2KML on the C50r SimGEN Host, type '*http://192.168.25.1*', which is the C50r SimGEN Host loopback address preceded with 'http://'.

→ Finally, add the port number you entered in **SimGEN2KML-IP settings-Port number** to the IP address as follows. Append the IP address with a colon, type the port number and append a forward slash to the port number.
For example, if you use the default port with the loopback address 127.0.0.1, type 'http://127.0.0.1:16700/', as in this figure.

→ Click the **Refresh** tab.

→ Select **Time-Based Refresh-Periodically** and set the time to **1 secs**.

→ Select **Fly to View on Refresh**, as in the figure below:



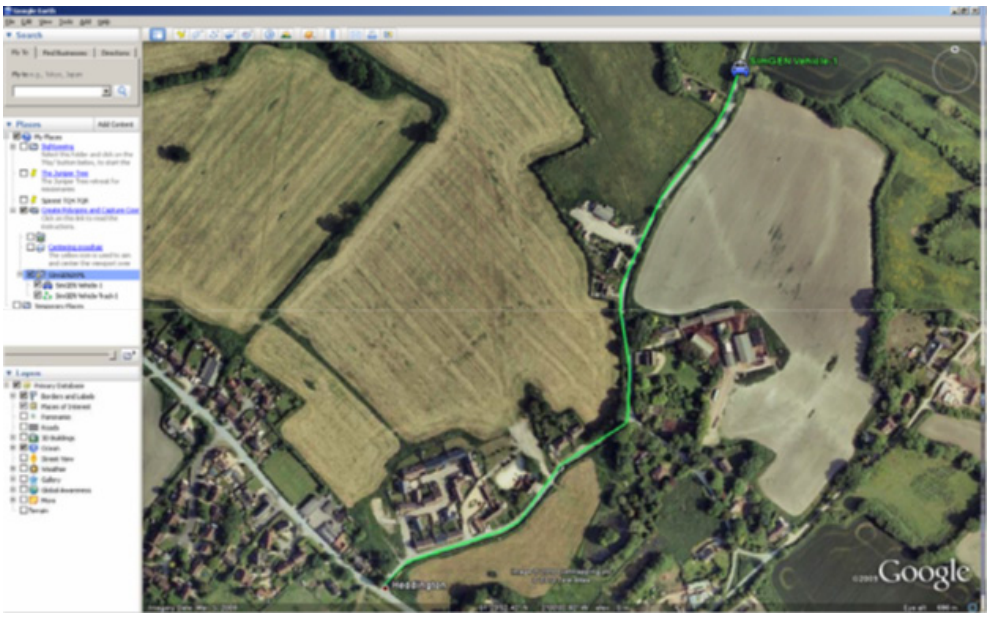

→ Do not make any further settings in Google Earth®.

→ Click **OK**.

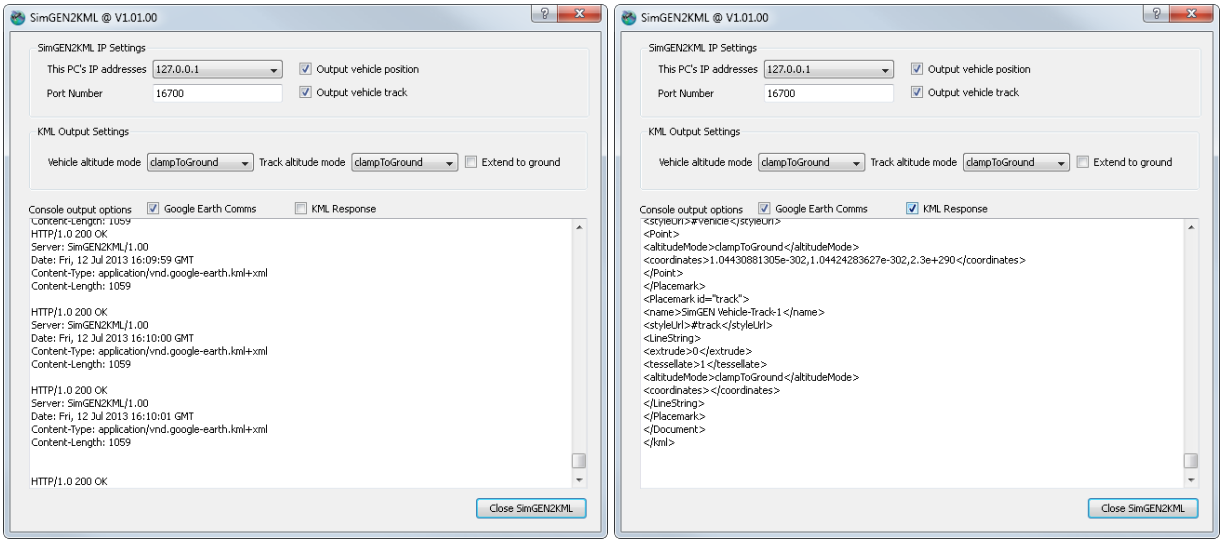
→ Start the simulation by clicking by clicking the SimGEN toolbar button  .

SimGEN starts simulating the trajectory, or route, of your vehicle and Google Earth® updates the position of your vehicle every second, as in the figure below:


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With these settings the SimGEN2KML utility updates every second. The following figures show SimGEN2KML when you select **Console Options-Google Earth comms** and **Console Options-KML Response**




→ Click **Close SimGEN2KML** to close the utility.


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# 27 Abbreviations, acronyms and terms

**Abbreviations and acronyms**

| Acronym / abbreviation | Description |
|---|---|
| A-S | Anti-Spoofing |
| ASCII | American Standard Code for Information Interchange |
| BITE | Built In Test Equipment |
| C/A code | Coarse/acquisition code |
| CDMA | Code Division Multiple Access |
| CRC | Cyclic Redundancy Check |
| CSV | Comma Separated Variable |
| CW | Continuous Wave |
| CofG | Centre of Gravity |
| DLL | Dynamically Linked Library |
| DOP | Dilution Of Precision |
| ECEF | Earth Centred Earth Fixed |
| ECI | Earth Centred Inertial |
| ECM | Electronic Counter Measures |
| EGNOS | European Geostationary Navigation Overlay System |
| EMS | EGNOS Message Service |
| ESA | European Space Agency |
| EVTP | Enhanced Validation Test Program |
| FDMA | Frequency Division Multiple Access |
| FEC | Forward Error Correction |
| GIVEI | Grid Ionospheric Vertical Error Indicator |
| Ground Transmitter | Ground Transmitter - an embedded interferer in dual L1 capable GSS4760 and GSS7700 signal generators |
| GDOP | Geometric Dilution of Precision |
| GLONASS | GLObal NAvigation Satellite System |
| GNSS | Global Navigation Satellite System |
| GPS | Global Positioning System |
| GUI | Graphical User Interface |
| HDOP | Horizontal Dilution Of Precision |
| HOW | Hand -Over Word |
| ICD | Interface Control Document |
| IGP | Ionosphere Grid point |
| IMU | Inertial Measurement Unit |


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| Acronym / abbreviation | Description |
|---|---|
| INS | Inertial Navigation System |
| IODC | Issue of Data, Clock |
| IODE | Issue of Data, Ephemeris |
| ISC | Inter-Signal Correction |
| L1 | GPS primary D-band carrier frequency, 1575.42 MHz<br>GLONASS frequency L1 |
| L2 | GPS secondary D-band carrier frequency, 1227.6 MHz<br>GLONASS frequency L2 |
| L5 | 3rd GPS D-band carrier frequency, 1176.45 MHz |
| LAAS | Local Area Augmentation System |
| LSB | Least Significant Bit |
| MHz | Megahertz (106 Hz) |
| MSAS | MTSAT Satellite Augmentation System |
| MSB | Most Significant Bit |
| MT | Message Type |
| Nav Data | Navigation data message |
| NMCT | Navigation Message Correction Table |
| P-code | Precise Code |
| PDOP | Position Dilution Of Precision |
| PPS | Precise Positioning Service |
| PRN | Pseudo Random Noise |
| Rinex | Receiver Independent Exchange Format |
| RT | Remote Terminal |
| SAAS | Selective Availability and Anti-Spoofing |
| SAIF | Sub metre-class Augmentation with Integrity Function |
| SBAS | Satellite Based Augmentation System (such as WAAS or EGNOS) |
| Spirent | Spirent Communications plc |
| SPS | Standard Positioning Service |
| TGP | Tropospheric Grid Point |
| TDOP | Time Dilution Of Precision |
| TFOM | Time Figure Of Merit |
| TLM | Telemetry Word |
| TOW | Time Of Week |
| UDRA | User Differential Range Accuracy |
| UE | User Equipment |
| UTC | Universal Time Co-ordinated |


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| Acronym / abbreviation | Description |
|---|---|
| UTC(SU) | Universal Time Co-ordinated maintained by Russia |
| UTC(USNO) | Universal Time Co-ordinated maintained by US Naval Observatory |
| UTC | Universal Time Co-ordinated |
| VDB | VHF Data Broadcast |
| VDOP | Vertical Dilution Of Precision |
| WAAS | Wide Area Augmentation System |
| WAGE | Wide Area GPS Enhancement |
| WGS84 | World Geodetic System, 1984 |
| Y code | Precise Code, A-S mode |
| <CR> | Used in code to indicate a Carriage Return<br>Pressing the return key gives <CR> followed by <LF> |
| <LF> | Used in code to indicate a Line Feed |

**Terms**

| Term | Description |
|---|---|
| Analysis | The third and final stage of simulation where the data logged from the UUT may be analysed and displayed in graphical or tabular form. |
| Cut-over | A scheduled change in the navigation data set that a satellite transmits. |
| Definition | The first stage of simulation where the user specifies the characteristics of the scenario and produces a complete set of information to enable the system to operate the Run-Time |
| Interference Simulator | Signal generator, which simulates adverse and hostile electromagnetic environments. |
| C50r SimGEN Host | The Host running SimGEN for GSS9000-series signal generators |
| Model | Software program, which takes in input data, performs a number of algorithms on that data and produces an output file(s), or data. The database uses the term "model" to mean one complete set of input file(s) and related output file(s) from such a software program. |
| Run-Time | The second stage of simulation. This is the real-time phase, which uses the parameters from the definition stage to calculate the data and drive the signal generator to provide real-time stimuli to the UUT. |
| Scenario | A complete description of a simulation. |
| SimGEN Controller | The computer that controls GSS8000-series and earlier signal generators. It prepares data to drive the signal generator, analyses the results of simulation and performs related housekeeping and miscellaneous functions. |
| Simulator | A configured arrangement of Spirent signal generator(s), computer controller(s) and ancillary items. |
| Time into run | day (relative to start of scenario) / hours / minutes / seconds.<br>For example, Duration in SimGEN's Date/Time window is a true time.<br>***Note**: Time into run may be given in seconds* |


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| Term | Description |
|---|---|
| True time | day - month - year / hours / minutes / seconds.<br>For example, Start time in SimGEN's Date/Time window is a true time |
| Upload | A change in the navigation data set transmitted by a satellite due to the Control Segment updating the satellite's memory.<br>In a Spirent simulator, the term "Upload" refers to data in use because of the Control Segment Update. |
| UUT | Unit Under Test. |



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# 28 Spirent Global Services

During normal office hours, you can contact Spirent Global Services in the United Kingdom, Asia Pacific and the USA by e-mail, fax or telephone. The Global Services contact details are on the next page.

Spirent Global Services can provide general information on any aspect of Spirent simulator hardware or software; or they can answer specific questions. Spirent Global Services is available to all customers under Warranty or with a maintenance agreement. Please note that Spirent Global Services is available to customers without a maintenance agreement, but Spirent is not obliged to provide solutions to any customer without a maintenance agreement.

Spirent Global Services aims to respond (or, where necessary, initiate a System Report) to any query within one working day (local and national holidays permitting).

Spirent requests you tell them when your simulator behaves in an unexpected, unusual or unacceptable way; including suspected faults or errors in the hardware, software or documentation.

Spirent's fault reporting system will ensure Global Services can quickly return your simulator to normal working operation. After contacting Spirent Global Services to report a fault, Global Services staff will create a System Report (SR) and copy you with the SR reference number. Spirent Global Services request you use the SR reference number in all correspondence relating to that incident. All responses from Spirent in relation to your incident will contain the SR reference number.

When you first contact Spirent Global Services to report a fault, please provide the following information:

- ✓ Your name
- ✓ Your e-mail address
- ✓ Your telephone or fax number
- ✓ The types and version numbers of your Spirent software
- ✓ The serial number of your signal generator
- ✓ A comprehensive description of the incident

Where appropriate, provide:

- ✓ A copy of the [executable filename]_message_log.txt file
- ✓ Copies of your scenario files, including all shared files. Provide a separate list, as a plain text (*.txt) file, of all files you send Spirent.
- ✓ Details of the repeatability of the incident
- ✓ Details of changes to the system, including any new software added and all upgrades (including Windows, new hardware, new drivers, Spirent software and so on)

This will enable a swift response and improve the service to you.


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Spirent Global Services contact details:

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Tel (Outside mainland China): +86 4008109529
Fax: +86 1082330022
E-mail: help_asia@spirent.com

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United Kingdom

Contact Global Support:
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Fax: + 44 1803 546302
E-mail: help@spirent.com

Go to http://support.spirent.com for access to Spirent's Global Support, FAQ and document databases.


SimGEN software user manual
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United Kingdom

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**SIMGEN SOFTWARE USER MANUAL**
**SOFTWARE FOR THE SPIRENT**
**RANGE OF SATELLITE**
**NAVIGATION SIMULATOR PRODUCTS**

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Document number: DGP00686AAA
Document Issue: 6-00
Date of Issue: 29 September 2016
Printed in England